National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Early Detection of Invasive Plant Species in the San Francisco Bay Area Network

A volunteer based approach

Natural Resource Report NPS/SFAN/NRR—2009/136

ON THE COVER
Golden Gate National Parks Conservancy employee Elizabeth Speith gathers data on an invasive *Cotoneaster* shrub.
Photograph by: Andrea Williams, NPS.

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Executive Summary

The mission of the National Park Service is "to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations" (NPS 1999). To uphold this goal, the Director of the NPS approved the Natural Resource Challenge to encourage national parks to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring (NPS 1999). Through the Challenge, 270 parks in the national park system were organized into 32 inventory and monitoring networks.

The San Francisco Bay Area Network of National Parks identified vital signs, indicators of ecosystem health, which represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales. The intent was to monitor a balanced and integrated "package" of vital signs that meets the needs of current park management, but will also be able to accommodate unanticipated environmental conditions in the future. Invasive plant species, as a major stressor, ranked highly as a vital sign. There are two main components of the invasive species monitoring program, each with separate protocol narratives and standard operating procedures (SOP's). The first component, this protocol, is early detection monitoring to locate new, isolated infestations before they become entrenched in the Network parks. Because it lacks hypotheses and trend analyses with power, it has been deemed a management, not a monitoring, protocol; although it does not make any recommendations for managing invasive species.

The San Francisco Bay Area is part of one of the six most significant areas in the nation for biodiversity; human population and the area's place in global trade both place exotic species propagule pressure on the national parks in this region. Prioritizing prevention, early detection, and rapid response, while continuing ongoing control, will allow the parks to deal with invasive plant species in a more cost-effective and strategic manner. This protocol presents logical methods and guidance for where, how often, and for what to search; the types of data to gather; and recommended training levels for volunteers and staff, to better glean data from some of the millions of people out in our national parks annually.

Three objectives provide the framework for early detection monitoring: developing and revising a list of target invasive plants, whose priority determines the level of data gathered; ranking park subwatersheds by management priority, risk, and current infestation level to generate priorities for monitoring frequency; and regularly evaluating and examining invasive plant monitoring data to revise and refine priorities, as well as clarifying contributing factors to new invasions in the park.

The list of target species for each park was based on current knowledge and rankings, summing recognized invasiveness and biological ease of control and stratifying into priorities by feasibility of control based on species' infested acreage in the park. A list of all exotic species known or thought to occur in the parks (~300 species; see Appendix A), compiled from NPSpecies, was the base list. After removing known non-invasive species, and species locally non-native, 174 species remained. Species listed by the California Invasive Plant Council (Cal-IPC), California Department of Food and Agriculture (CDFA), The Nature Conservancy (TNC), and local Weed

Management Areas received varying numbers of points for invasiveness, as did unlisted species which shared invasive characteristics with a listed congener. Based on best available knowledge, species also received points for altering ecosystems—affecting a system change, not just crowding out other plants—and for endangering rare plants in SFAN parks. Next, based on best available knowledge, species were ranked by ease of control independent of number of acres infested. All points were summed for the overall invasiveness score, then sorted according to feasibility of control based on number of acres infested with that species, cost for removal, politics, and access. "Controllable" acreage was based on the size of the park unit and annual area treated by their exotics program, and varied slightly by park. Species shown to be highly invasive, but not widespread in the park, are top priority for detailed mapping; more widespread but still invasive species are mapped with a point unless populations are small.

The list of priority areas for searches was made by ranking subwatersheds—drainage-based subunits of watersheds—by number and degree of current infestations; risk of further infestation; and priority of resources present. Subwatersheds were ranked, grouped along the most natural breaks, and assigned a score. Total score was obtained by adding risk to weighted (2x) rare species priority score and subwatersheds approximately quartered into high, significant, moderate, and low priority. High-priority subwatersheds are visited annually; significant and moderate, biennially; and low, once every five years.

Surveys cover roads and trails, with data collection ranging from simple (presence/absence during a survey) for low-priority species or Level 1 volunteers to complex (digital point and polygon data, as well as associated phenological and habitat data, taken with a handheld unit) for highly skilled volunteers and staff and high-priority species. Information is stored in GeoWeed, Sonoma Ecology Center's improvement on The Nature Conservancy's Access-based vegetation management information system WIMS. GeoWeed (http://geoweed.org), like WIMS, is freely available and allows for digital data collection through a series of ArcPad forms. Negative data are tracked through the use of the "Survey Area" portion of the database.

Acting upon new detections of invasive species is critical, so monthly reports go out to park staff and interested parties, in addition to sharing a common database. Annually, all staff involved with invasive species work meet to review maps for completeness and accuracy, and to provide feedback on the early detection program. Annual reports will include number of occurrences by subwatershed and by species, and the time spent surveying and miles covered; and maps of locations and presence/absence of species by subwatershed. Any revisions to the species list will also be covered. Long-term trend reporting will focus on trends in species distributions: spread rates by habitat type and trends in number of detections.

Outreach and collaboration are essential to this protocol; additional products for non-vegetation staff and the public include presentations and trainings on priority invasive species; laminated "Plant-out-of-Place" priority species identification cards, lists with photographs of invasive plants found during surveys; and articles for publications such as "Noxious Times," "Cal-IPC News," "Park Science," or "Fremontia." Collaborations include local Weed Management Areas and the Bay Area Early Detection Network, an expansion of park-based early detection to lands throughout the Bay Area.

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1.0 Introduction

1.1 Why Perform Early-Detection Monitoring for Invasive Plant Species?

Globalization of commerce, transportation, human migration, and recreation in recent history has introduced non-native species (also referred to as exotic, alien, or non-indigenous species; see Glossary) to new areas at an unprecedented rate. Biogeographical barriers that once restricted the location and expansion of species have been circumvented, culminating in the homogenization of the Earth's biota. Although only an estimated 10% of introduced species become naturalized and only 1% become problematic (Williamson 1993, Williamson and Fitter 1996) or invasive, non-native species have profound impacts worldwide on the environment, economies, and human health. Invasive species have been directly linked to the replacement of dominant native species (Tilman 1999), the loss of rare species (King 1985), changes in ecosystem structure, alteration of nutrient cycles and soil chemistry (Ehrenfeld 2003), shifts in community productivity (Vitousek 1990), reduced agricultural productivity, and changes in water availability (D'Antonio and Mahall 1991). Often the damage caused by these species to natural resources is irreparable and our understanding of the consequences incomplete. Invasive species are second only to habitat destruction as a threat to wildland biodiversity (Wilcove *et al*. 1998). Consequently, the dynamic relationships among plants, animals, soil, and water established over many thousands of years are at risk of being destroyed in a relatively brief period.

For the National Park Service (NPS), the consequences of these invasions present a significant challenge to the management of the agency's natural resources "unimpaired for the enjoyment of future generations." National Parks, like other land management organizations, are deluged by new non-native species arriving through predictable (*e.g*., road, trail, and riparian corridors), sudden (*e.g*., long-distance dispersal through cargo containers and air freight), and unexpected anthropogenic pathways (*e.g*., weed seeds in restoration planting mixes). Non-native plants claim an estimated 4,600 acres of public lands each year in the United States (Asher and Harmon 1995), significantly altering local flora. Invasive plants infest an estimated 2.6 million of the 83 million acres managed by the NPS.

More NPS lands are infested daily despite diligent efforts to curtail the problem. Impacts from invasive species have been realized in most parks, resulting in an expressed need to control existing infestations and restore affected ecosystems. Additionally, there is a growing urgency to be proactive—to protect resources not yet impacted by current and future invasive species (Marler 1998). Invasive species most certainly will continue to be a management priority for the National Parks well into the 21st Century.

The San Francisco Bay Area Network (SFAN) of parks—Fort Point National Historic Site, Golden Gate National Recreation Area, John Muir National Historic Site, Muir Woods National Monument, Pinnacles National Monument, Point Reyes National Seashore, and Eugene O'Neil National Historic Site—are part of California's central and southern coasts, one of the six most significant areas in the nation for biodiversity (Nature Conservancy 2000) and one of the top biodiversity hotspots for conservation in the world (Myers *et al.* 2000). These parks remain significant to the conservation of endemic species and communities, despite close proximity to the metropolitan centers of San Francisco, Oakland and San Jose—forecast to have a population of 8 million by 2020 (Association of Bay Area Governments 2000). Recognizing the extraordinary significance and exposure to threats in the region, the UNESCO Man in the Biosphere program designated the Central California International Biosphere Reserve in 1988 which includes several SFAN park units.

The parks within the SFAN are all either adjacent to or near urban settings, with private landowners along park boundaries. Many of these parks have been altered through human habitation—as home or work sites, agricultural or working landscapes. Due to the close proximity of development and urban boundaries, many of the invasive species found in the parks, and in much of California, are horticultural species that have spread as an unintended consequence of local gardening and landscaping. The best way to prevent further spread of these species into the parks is to be vigilant about patrolling in the wildland-urban interface settings. Trails, roads and waterways are the main routes of infestations in most natural areas, and the SFAN is no exception. Monitoring these pathways will be addressed in this protocol, along with identifying source populations and other disturbed areas within the parks. Monitoring the likely routes of invasion and uninfested areas is the most effective way to prevent the spread of existing species and the infestation of new species in SFAN parks (*e.g.*, McNeely *et al.* 2001).

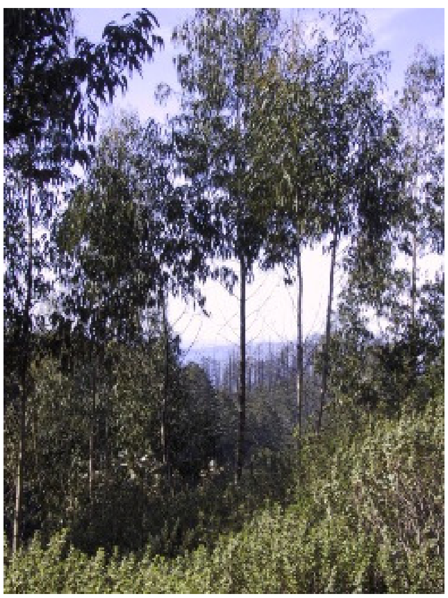

Figure 1. Invasive trees, such as this bluegum eucalyptus *(Eucalyptus globulus*), block park viewsheds.

Invasive plant species negatively affect park resources and visitor enjoyment in several ways, including altering landscapes and fire regimes, reducing native plant and animal habitat, and blocking views and increasing trail maintenance needs. Given the extraordinary biodiversity of the San Francisco Bay Area, and the development pressure on private lands in the area, SFAN parks serve as crucial refugia for native species. Over 100 rare plant species can be found in SFAN parks. Invasive plants threaten many of these rare species. In Golden Gate National Recreation Area (GOGA) alone, 25 species of non-native plants were noted as directly threatening rare plant populations (GOGA 2004).

Invasive plant species can also threaten park buildings and even historic landscapes and viewsheds. While non-native tree species planted historically contribute to the pastoral character or cultural landscape significance at several parks, some are spreading from plantings and present control problems. While invasive species affect park resources, they also impact adjacent non-park lands. Park neighbors include private landowners whose homes may be threatened by infestations of highly flammable bluegum eucalyptus (*Eucalyptus globulus*), or whose pastures are threatened by invasive thistles.

Figure 2. Distaff thistle (Carthamus lanatus) degrades a Point Reyes pasture.

Detecting invasive species before they become established has been a longstanding practice in agriculture, with point-of-entry and -distribution inspections, insect traps and nursery certification. In 2000, more than 33.5 million vehicles were monitored at the California border agricultural inspection stations. Over 70 thousand lots of prohibited material were intercepted at the border inspection stations, including musk thistle, diffuse knapweed, gypsy moth, imported fire ant, boll weevil, Mexican fruit fly, zebra mussel, pecan weevil, Japanese beetle, Oriental fruit fly, Mexican fruit fly, European corn borer, and burrowing nematode (CDFA 2005). Wildland managers have been slower to implement strong prevention and early detection programs; lack of clear regulatory oversight, funding/staffing, and vector control hamper such efforts.

Finding and removing invasive species before they impact native species will prevent further loss of biodiversity. At Point Reyes National Seashore (PORE), for example, removal of invasive European beachgrass (*Ammophila arenaria*) as part of the coastal dune restoration program has already resulted in reestablishment of federally endangered plants Tidestrom's lupine (*Lupinus tidestromii*) and beach layia (*Layia carnosa*), and nesting of federally threatened western snowy plover (*Charadrius alexandrinus nivosus*) (Peterson *et al.* 2003).

Through direct monitoring of an ecosystem stressor, invasive plant species early detection fulfills several Inventory and Monitoring directives, although it has been deemed a management protocol and not a monitoring protocol. The stated goals of the Inventory and Monitoring Program are as follows:

1. Determine the status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.

By tracking occurrences, location, and extent of priority invasive species, this protocol allows managers to put control efforts where they will do the most good. The prioritization of species and areas can be used to inform resource work as well. The collaboration section (1.8) outlines several ways in which the program plans to work with others for the benefit of park and regional resources.

2. Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.

Early detection through this protocol allows managers to control invasive plant populations at the most cost-effective stage.

3. Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.

Analysis of detection data over time will help show the vulnerability of different ecosystems, and the invasion timeframe in each. When coupled with data from planned status & trends of invasives monitoring and plant community change monitoring, managers will better understand lands at risk.

4. Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment.

Early detection helps meet mandates as outlined in Section 1.2.2, below.

5. Provide a means of measuring progress towards performance goals.

Early detection data is linked with park data on control, and can be used in measuring baseline acreages and progress toward GPRA goals.

1.2 Policies and Guidance Related to Invasive Species

1.2.1 Guidance Documents and Existing Plans

In 2002, the National Research Council thoroughly reviewed the state of knowledge on invasions, including predicting introductions and establishment. Their key recommendations for furthering knowledge and preventing invasions of non-native species include the following:

- "Careful recording of the circumstances of arrival, persistence, and invasion of non-indigenous species in the United States would substantially improve prediction and risk assessment."
- "Information on the structure and composition of natural ecosystems in North America (and the disturbance regimes within them) should be reinterpreted by the scientific community to analyze these ecosystems' vulnerability to biotic invasion. Attention should be paid to identifying groups of native species that could be vulnerable or could facilitate the establishment of non-indigenous species."

- "A central repository of information relevant to immigrant species would accelerate efforts to strengthen the scientific basis of predicting invasion. Information collected by federal, state, and international agencies, academic researchers, and others should be brought together in a single information facility or service so that it can be evaluated collectively, to permit the construction of needed datasets and the design of appropriate experiments, and to document the circumstances surrounding invasions."

The Council's recommendations were further developed by the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) into a conceptual design for "A National Early Detection and Rapid Response System for Invasive Plants in the United States" in 2003. The plan identifies actions, objectives, and resources needed (and currently available) for an EDRR system to function at local, state, and national levels.

The State of California's 2005 "California Noxious & Invasive Weed Action Plan" developed by the California Department of Food and Agriculture, as well as the California Invasive Weed Awareness Coalition, also puts forth comprehensive needs and selected actions for EDRR as part of an overall strategy that includes Leadership, Prevention and Exclusion, Eradication and Management, Research, and other aspects of a broad, thorough weed management framework.

Through the development and implementation of this protocol, the San Francisco Bay Area Network will be acting on several of these important recommendations, and a contributing to the greater body of knowledge regarding the threat of invasive species in the United States.

This protocol will also serve to meet invasive species goals that were mandated by the National Park Service as part of the Natural Resource Challenge that established 32 Inventory & Monitoring (I&M) networks across the United States (National Parks Omnibus Management Act of 1998 [P.I. 105-391]). In 2002, the NPS I&M program held a workshop to recommend guidelines and tools for developing protocols for inventory and monitoring of invasive plants. One of the four adopted goals is to "prevent and detect new alien plant invasions, and eradicate new invasives" (Hiebert 2002, Benjamin and Hiebert 2004). The group developed a preliminary flowchart of the components of an effective weed monitoring program and adopted the North American Weed Management Association standards (Beard *et al.* 2001). This protocol meets the goal established in 2002 and follows standards that have been recently developed through the draft USGS-NPS Early Detection of Invasive Plants Handbook (Welch *et al.* 2007).

The NPS Invasive Species Action Plan (NPS 2006a) includes specific, recommended actions ranging from leadership and coordination to restoration. This protocol meets or helps to meet the guidelines and suggestions of the following actions from the plan:

- 1A.2: Develop NPS capability at a regional or multi-park level.
- 1B.1: Expand partnerships to maximize results.
- 1B.4: Enhance national, regional, and state interagency coordination.
- 1B.5: Identify mechanisms to work on land adjacent to park in discretionary cooperative efforts.

- 1C.3: Rank invasive species for each park unit.
- 3A.3: Contribute to the development of national standards for all aspects of invasive species management.
- 6A.2: Improve the quality of the invasive species data in NPSpecies.
- 6A.3: Improve the quality of the invasive species data in NR-MAP.

1.2.2 Laws and Policy

Invasive species have been recognized as a threat to the nation's resources for many years. Executive Order 13112 (1999) summarized the many statutes that had been used to authorize the prevention and reduction of invasive species infestations in the United States of America; defined key terms; established the Invasive Species Council; directed federal agencies to prevent the spread of invasive species and, where feasible, remove established populations. The statutes mentioned in the order include the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 *et seq*.), Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 U.S.C. 4701 *et seq*.), Lacey Act, as amended (18 U.S.C. 42), Federal Plant Pest Act (7 U.S.C. 150aa *et seq*.), Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801 *et seq*.), Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.). Invasive species threaten park habitats, and managers may cite the Organic Act of 1916, the parks' enabling legislation, or NPS Management Policies Section 4.4 (2006b) to preserve and protect areas from invasive species.

1.3 Parks Involved in Monitoring

The following network parks are included in early detection monitoring: Fort Point National Historic Site (FOPO), Golden Gate National Recreation Area (GOGA), John Muir National Historic Site (JOMU), Muir Woods National Monument (MUWO), Pinnacles National Monument (PINN), and Point Reyes National Seashore (PORE). Following testing at GOGA, the protocol will be adapted for use at other parks.

1.4 Vital Sign Integration

Invasive plant species alter ecosystem function and impact several species chosen as indicators by the SFAN. The narrow focus of this protocol—rapid, on-the-ground surveys for selected invasive plant species—precludes capture of detailed information usable in the study of other vital signs. The second aspect of invasive plant species monitoring, status and trends, will be integrated with plant community change monitoring, and that monitoring will provide data used to analyze invasion outside the roads and trails network. Early detection prioritization also takes data from rare plant and animal species monitoring into account when prioritizing search areas. Additionally, staff performing monitoring for other vital signs will be trained to recognize and report priority invasive plants.

1.5 Significance to Management

Early detection of invasive species was ranked as the second-highest vital sign monitoring priority for SFAN Parks (Adams *et al*. 2006), and non-native species control or eradication was listed as a management objective in all parks. With tens to hundreds of thousands of dollars and hours spent annually, parks have placed high value on the control of invasive exotic plants. Early detection, coupled with rapid response by parks, will increase the efficiency of control programs.

Data from early detection will be used by parks in strategizing eradication efforts. With parks and Inventory & Monitoring (I&M) committed to using the same data-gathering system, a built-in feedback loop will enable all partners to track the status of exotic plant populations from discovery to removal. Parks have also each committed a number of work-hours per year to rapid response for populations detected through I&M efforts. Explicit population thresholds have not been set to trigger treatment by parks (such as those recommended by Foxcroft 2004); however, List 1 and 3.1 species are expected to be treated within two seasons, and new populations of List 2 species within five. At the five-year review period of this protocol, rapid response to populations will be looked at as well.

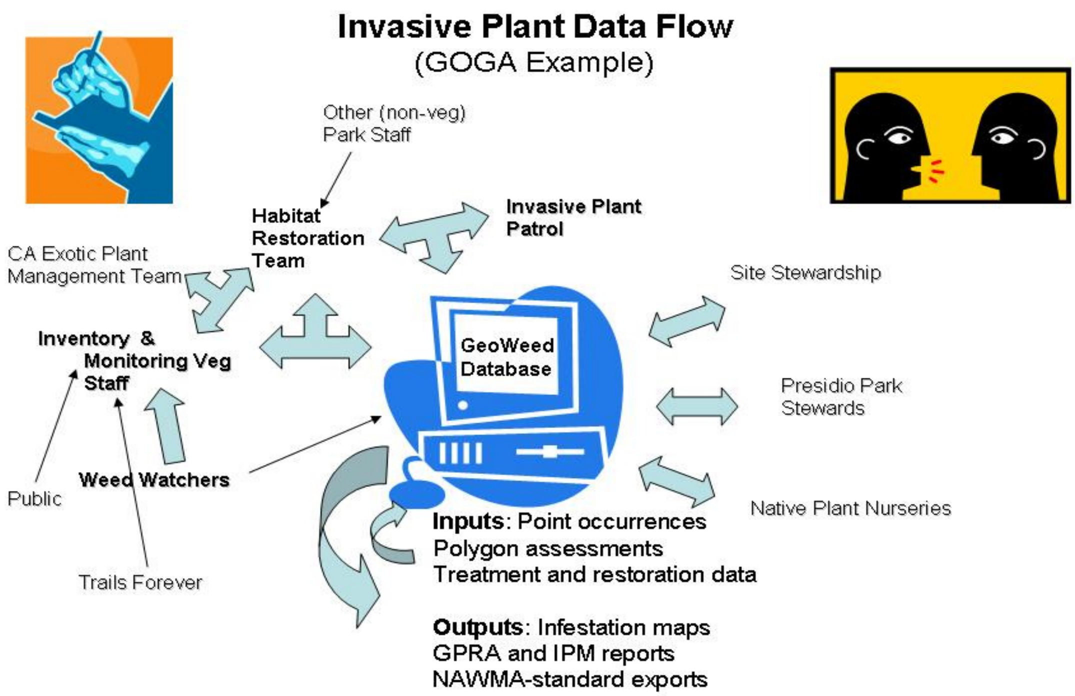

Figure 3. Projected data flow between partners at GOGA and the central database, showing the complexity of invasive plant data collection and sharing.

1.6 Exotic Species at SFAN Parks

Several things have been suggested as factors in the invasion process: disturbance (Johnson *et al.* 2006), propagule pressure, and plant community susceptibility (Stohlgren *et al.* 2005) are most often recognized as major influences outside of characteristics of the invasive species itself. Several of these aspects were approximated for SFAN parks to explore which may be correlated with the number of exotics and/or invasives. Past land use history, year of establishment, current visitation, miles of roads and trails, length of perimeter, and size of park were compared against number of exotics, number of invasives, percent of flora exotic or invasive, and purported origin of invasives. Size of park was most clearly correlated with the total number of species present; progressively less so with number of exotics and number of invasives (Figure 4, below; data from NPSpecies 2007 and Operations Formulation System 2007).

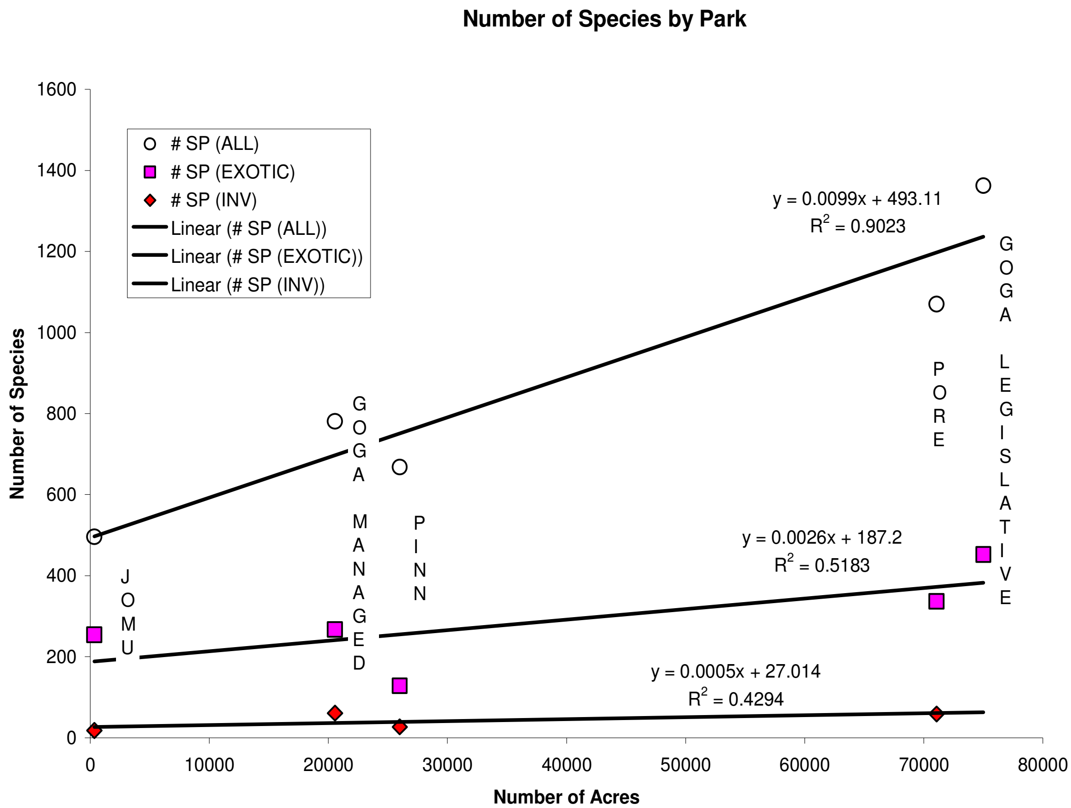

Figure 4. Relationships between park area and number of species present. Note that species were not ranked for invasiveness for legislative-boundary Golden Gate, so there is no point on that line.

The effects of visitation, miles of roads and trails, and length of perimeter appear dwarfed by the past land use history and year of establishment, as shown in Table 1. Such effects are also illustrated by a recent inventory of new lands at Pinnacles National Monument (Williams 2008). A comparison of PINN as a whole, to the impacted grassland of the entrance meadow, to the recently acquired grazing lands less than two miles away show the effects and effectiveness of land protection. Overall, PINN is the least-invaded and longest-protected park; only 19% of its flora is non-native and less than 5% invasive (based on SFAN ranking system, total score 5 or greater). The east-side entrance meadow, a previously burned and heavily invaded grassland nestled between the entrance road and a trail, shows a high level of invasion. But compared to the similarly sized “airstrip” area, until recently a much more heavily used landscape, the meadow is a haven for native diversity. While such single-site comparisons are not definitive, such anecdotes suggest the strong influence of the land’s disturbance history on its current extent of invasion.

While disturbance history cannot be altered, the strong correlation between disturbance and exotic species can be used to focus surveys in areas which are frequently disturbed: most generally, along road and trail corridors. Several studies show strong associations between roads and trails and exotic species (*e.g.,* Harrison *et al.* 2002, Parendes and Jones 2000, Gelbard and Belnap 2003), whether due to the disturbance of building transportation corridors; propagules brought in with soil or on vehicles or people; or altered resource availability due to local light or soil characteristics. While riparian corridors share some characteristics—frequent disturbance, potential translocation of propagules, and altered resource availability—with transportation corridors, they are not a focus for the primarily volunteer-focused surveys at GOGA or PORE. Staff will train other resource personnel, such as fish or water quality technicians, who regularly travel riparian corridors to record opportunistic sightings; staff will also be able to map populations along roads or trails which parallel or intersect riparian areas. A simple GIS analysis (clipping road/trail and stream layers to park boundary, converting stream line to points, buffering road/trail 20 meters, and using Hawth's "Count points in polygon" tool) shows that 51% of stream points fall within 20 meters of a road or trail at PORE, 10% at GOGA, and 11% at PINN. Given these statistics, staff may actually survey a good deal of riparian corridor. Ancillary data collected during surveys should assist in identifying possible additional factors in invasion.

Table 1. Apparent influential factors in the extent of invasion at parks.

Park Name	Acres in Park	# of Natives	# of Exotics	# of Invasives	% Flora Exotic	% Flora Invasive	Year Established	Prior Use (50 yrs)
EUON	13	84	112	18	57.1%	17.6%	1976	Home
JOMU	345	242	254	18	51.2%	6.9%	1964	Home
GOGA Managed	20,556	514	267	61	34.2%	10.6%	1972	Military, Ranch
PINN	26,000	540	128	27	19.2%	4.8%	1908	National Monument
PORE	71,070	733	337	59	31.5%	7.4%	1962	Agriculture, Openspace
All GOGA	75,000	910	452	61	33.2%	6.3%	1972	Military, Ranch, Openspace, Agriculture,
PINN Entrance	8	47	19	7	28.8%	13.0%	1908	National Monument
PINN Airstrip	8	17	22	8	56.4%	32.0%	2004	Ranch

1.7 Past Invasives Work at SFAN Parks

"The most critical step in addressing new invasive plant problems is to know they exist." (FICMNEW 2003). Prior to the inception of the Inventory and Monitoring (I&M) program, many SFAN parks already had invasive plant maps, removal programs and even monitoring efforts in place. The I&M program assisted these efforts by initially providing funds for inventories of vascular plants. The inventories allowed JOMU to map many of the populations of invasive species, and PINN included invasive species in the inventory of new lands and as part of the vegetation mapping project.

1.7.1 Golden Gate National Recreation Area

Golden Gate NRA has several programs working exclusively on invasive species removal and restoration of native habitat. The Habitat Restoration Team (HRT), funded largely by the park with support from the Golden Gate National Parks Conservancy, began in 1992, and has grown into a large-scale invasive plant removal program. The team, and its early-detection/follow-up-focused offshoot, the Invasive Plant Patrol, have set routes and priority infestations they treat weekly in summer and monthly in fall/winter. Three to seven core volunteers are often augmented by groups of 20 or more. The Site Stewardship Program [SSP] "is a Golden Gate National Parks Conservancy volunteer program, created in 1993. SSP's mission is to bring people together to protect ecologically sensitive areas within the Golden Gate National Recreation Area" (GGNPC 2004). The SSP focuses on restoration at areas of concern for endangered species within GOGA. The Parks Conservancy runs several similarly successful volunteer groups such as Trails Forever, and the Native Plant Nurseries. The park and Presidio Trust also manage the Presidio Park Stewards, who perform stewardship activities on Presidio lands. GOGA logs 25,000 hours of plant-related volunteer hours annually; these programs are part of 150,000 volunteer hours worked for natural resource programs each year at the park (S. Fritzke, pers. comm. 2006).

Surveys of targeted invasive non-native plants were initiated at GOGA in 1987. These surveys were conducted by qualified botanists who hand-mapped species infestation sizes and distributions using USGS quad maps. In 1995 GOGA began collecting invasive plant species data on the Presidio and in Gerbode Valley using GPS equipment. Between 1996 and 1998 survey and monitoring efforts were continued, however many were not well-planned and were inconsistently implemented. As a result, different park programs and projects used a variety of mapping protocols based upon their variable needs and available resources, leading to a wealth of useful but disjointed information. GOGA staff developed the "Manual for Surveying and Mapping Invasive Species" in 1999 (GGNRA 1999) to address this, and was piloted as part of the Redwood Creek watershed data collection efforts. While it provided consistency and a protocol for data collection that was used in a number of park watersheds, it did not take into account some of the specific GPS/GIS and data management challenges we now face, and few current weed workers are aware of its existence. GOGA's current method of documenting weed patches and infestation areas as well as weed management activities is a Microsoft Access application (the Restoration Database) that does not allow the input of spatial data. As a result, spatial weed survey data are recorded and stored in an entirely different place and manner (in scattered GIS shapefiles) than weed treatment data. Finally, only the watershed-based mapping efforts in 1999 and 2000 recorded the actual survey areas and list of species inventoried. While we know some historic and current locations of many invasive non-native plants, we cannot be sure that areas with no data are weed-free. Staff and volunteers work on 104 of the 340 non-native plant species known in the parks, focusing on incipient populations and high-priority sites, but detection varies by area and staffing availability—*e.g.*, the Presidio is well-traversed but northern Marin is not often visited.

1.7.2 Point Reyes National Seashore

In 1989, Point Reyes National Seashore (PORE) produced an Exotic Plant Management Plan. One aspect of this plan was a ranked list identifying invasive species for early detection. In 1994, PORE established the Habitat Restoration Program (HRP). Modeled after HRT at GOGA, this volunteer group focused on high-priority species removal and limited data collection (location, species, hours worked, quantity accomplished). In 2002, PORE staff developed an SOP outlining data collection and management procedures. Currently, projects at PORE focus on 20 high-priority species and include a 300-acre coastal dune restoration project, cape ivy (*Delairea odorata)* control, coastal bluff iceplant removal, and pampas and jubata grass *(Cortaderia jubata)* control, largely funded through national NPS funding via the Servicewide Comprehensive Call. PORE uses a work-performed database similar to GOGA's, with initial point occurrences and UTM's entered and used to track work on an infestation over time (PRNS and Babalis 2002). Early detection is done on an opportunistic basis by staff and volunteers. Incipient populations of gorse, spartina, yellow starthistle, and giant plumeless thistle are controlled by staff and park partners as time allows. PORE is also the base for the California Exotic Plant Management Team (CAEPMT), so the park also functions as a *de facto* California Parks nexus and base of control expertise.

Figure 5. Jubata grass control along sensitive coastal bluffs demonstrates the high skill, and cost, often necessary in control efforts.

1.7.3 Other Network Parks

Other network parks have existing programs and efforts underway. Invasive plant control at Pinnacles National Monument (PINN) is dependent on the park's ability to find funding and hire seasonal employees. When possible, the seasonal technicians target species in priority areas for removal each year. Much of the invasive species information for John Muir National Historical Site is based on vascular plant inventories conducted through the I&M Program. The comprehensive species lists included invasive species for the park. Similar to other parks, invasive species control at JOMU is done by securing funds through the Servicewide Comprehensive Call and support from the CAEPMT.

Network parks have numerous programs aimed primarily at invasive species control, but information is rarely shared among parks or programs run by different organizations. Parks have varying levels of capacity, and lack a reliable and comprehensive method of obtaining a bigger picture. The network protocol builds on the existing volunteer capacity of parks, and focuses on helping parks target their efforts, and collect and share quality information.

1.8 Collaboration

The goals of this monitoring strategy are to formalize and build on current knowledge (documented in GIS and databases) of species locations, spot new infestations, and notify park managers so they can eradicate infestations at more cost-efficient stages. Given the widespread problem of invasive species in the San Francisco Bay Area and spread of infestations across park boundaries, close coordination through local Weed Management Areas and through the California Invasive Plant Council will be an essential part of this early detection protocol.

Invasive species are a top priority for many landowners and managers. In California, Weed Management Areas (WMA's) and the California Invasive Plant Council (Cal-IPC) help agencies (governmental or non-), private landowners, interest organizations, and the public by serving to promote cooperation and acting as information clearinghouses. The large SFAN Parks are members in their regional WMA's: Marin-Sonoma, San Francisco, San Mateo, and San Benito; and have worked jointly on grant-funded projects through the WMA's. Parks also coordinate with adjacent agencies such as Marin Municipal Water District and California State Parks, often through WMA interactions. SFAN I&M staff are working collaboratively to build a Bay Area Early Detection Network (BAEDN), working with WMA's and State and Bay Area organizations such as the Bay Area Open Space Council's Stewardship Committee, the Association of Bay Area Governments, and Cal-IPC to share protocols, methods, materials, and reporting, and recruit and train early detection volunteers. The Marin-Sonoma WMA also has a nursery outreach program which will assist SFAN in identifying potential new invasives, and possibly prevent invasions through promoting voluntary codes of conduct for nurseries, landscapers, and landowners. This local effort also interfaces with a statewide (top-down) effort, the California Horticultural Invasives Prevention (Cal-HIP) "Plant Right" campaign (www.plantright.org), which works with major growers and distributors to substitute non-invasive species for problematic exotic species.

Using the Sonoma Ecology Center's (SEC) GeoWeed database is an additional way to facilitate collaboration. Based on The Nature Conservancy's database, Weed Information Management System (WIMS), SEC altered WIMS to create a back-end and front-end database structure, strengthen referential integrity, and increase data-sharing capability. GeoWeed is free, available to all users, and already in use by Team Arundo del Norte for use in multi-jurisdictional giant reed (*Arundo donax*) inventory, monitoring and control. GeoWeed follows the North American Weed Management Area (NAWMA) standards, and can be used for digital data collection as well as desktop data organization and reporting. Additionally, the Parks Conservancy and SFAN staff have worked closely to coordinate data collection methods, definitions and protocols that go beyond the basic NAWMA standards. SEC is also currently working to automate sharing of GeoWeed data through Cal-IPC and the National Biological Information Infrastructure. Data collaboration is an integral part of the SFAN and BAEDN efforts; the parks are a patchwork across the landscape, and facilitated information-sharing will help fill in the gaps.

2.0 Monitoring Design

2.1 Monitoring Questions

There are two main components of the invasive species monitoring program for the SFAN adapted from "Considerations for developing invasive exotic plant monitoring" (Thomas *et al.* 2002), each with separate protocol narratives and standard operating procedures (SOP's). The first component, and the focus of this protocol, is early detection monitoring to locate new, isolated infestations before they become entrenched in the Network parks. The second component is monitoring existing populations of species that are known to have the ability to change the structure and function of entire ecosystems. This involves choosing critical species in key habitats and monitoring the spread of invasives, and is planned for development in concert with the plant community change vital sign protocol. While monitoring known populations may seem less useful than removing them, understanding spread rates will help target efforts to the fastest-spreading species, refine models and revisit intervals for early detection, and lend confidence to estimates of "acres of infestation prevented" by rapid response programs.

Monitoring questions for SFAN early detection:

1. Where are new populations of invasive plant species becoming established along roads and trails in SFAN parks?

2. What are the features of road and trail corridors that make the best predictors for invasive species establishment?

3. Are invasive species spreading from roads and trails into sensitive or critical park habitat?

Looking for the worst plants in the best places

Parks need to know where incipient populations of highly invasive plants are becoming established, and protect the most critical areas from invasion. The objectives designed to answer the above monitoring questions focus on surveying road- and trail-side in priority areas using volunteers. Budget constraints necessitate looking in areas where it will do the most good—in high-quality and high-risk areas—along a primary vector for invasive plants, using volunteer labor. While surveyors may spot weeds far from the trail in the open scrub and grasslands of SFAN parks, true negative data (where weeds are not) and inferences will be limited to within several meters from roads and trails until plant community change data is available.

2.2 Protocol Objectives

The objectives for this protocol are as follows:

1. Develop and revise as needed (minimally, every three years) a list of target species for each park that do not currently occur in the parks, occur in localized areas of parks, or are extremely rare, but that would cause major ecological or economic problems if they were to become established in SFAN parks.

2. Prioritize SFAN subwatersheds by management importance, risk, and current infestation level. Within each park, use visual assessment and GPS technology to detect and map presence and absence of priority weed species along all roads and trails in the top ranked 25% of subwatersheds annually, the next 50% biennially, and the remaining 25% within five years (55% of all subwatersheds visited each year). [Revisit schedule may have to be re-evaluated based on search time from test; see also Harris *et al*. 2001.]

3. Every five years, evaluate invasive plant monitoring and mapping data collected to determine the primary pathways and predictive factors leading to new invasions along roads and trails in each park. Use the data to refine subwatershed rankings for search priority and timing. Identify possible management actions to prevent new infestations.

While only the second objective "qualifies" as a monitoring objective, all three are necessary to achieve the goals of this protocol. An additional objective addressing areas away from roads and trails will be added after the plant community change protocol is implemented.

Table 2. The two components of invasive species monitoring and how each protocol will address them.

Protocol	Purpose	Primary Measures	Area of Inference	Primary Reportables
Invasive Species Early Detection	Rapid, status-based monitoring for finding priority (rare) invasive plant populations	Point-based, or presence/absence	Along roads and trails	Number of detections by species per trailmile; maps
Plant Community Change	Trend-based monitoring for more widespread species	Frequency/cover or presence/absence	Landscape >50m from roads/trails	Infestation spread rates; models

2.3 Using Rapid Assessment Techniques

This protocol builds on and standardizes efforts already in place in many parks including volunteer programs, active detection programs for finding invasive species, and research. We have selected early detection for its proven utility in identifying infestations while they are small and cost-effective to control. Combined with rapid response programs, early detection helps to prevent invasion of uninfested areas. Early detection is also relatively easy to implement at several locations targeting a multitude of species with different levels of intensity. The chosen methods can be scaled based on resources available: from techniques for an opportunistic strategy with minimal staff in the field; to a full volunteer/staff program with targeted and systematic efforts based on location, seasonality, ground-truthing and removal in appropriate instances.

Qualitative techniques—such as the presence/absence data to be gathered for early detection monitoring—are less resource-intensive, easier to analyze and explain to stakeholders, and facilitate monitoring of a larger area (Elzinga *et al.* 2001; Dewey and Anderson 2004). Such low-intensity monitoring allows for a more rapid management response, as simpler data with no need for complicated analysis should lead to faster decision-making. Random plot-based sampling, even targeted to certain areas, is unlikely to capture very rare occurrences; relying on a volunteer effort for off-trail plot-based sampling is inappropriate due to unpredictability in quantity and quality of people. Large-scale sweeps of road- and trail-side will help ensure greater coverage, while capturing information to help inform future modeling to better target searches. Much of the parks is accessible by trail, and roads and trails are major vectors for invasive plants, which tend to clump along these corridors. Searching these areas will capture the greatest amount of information for relatively low effort, especially considering the long sight distances in the parks.

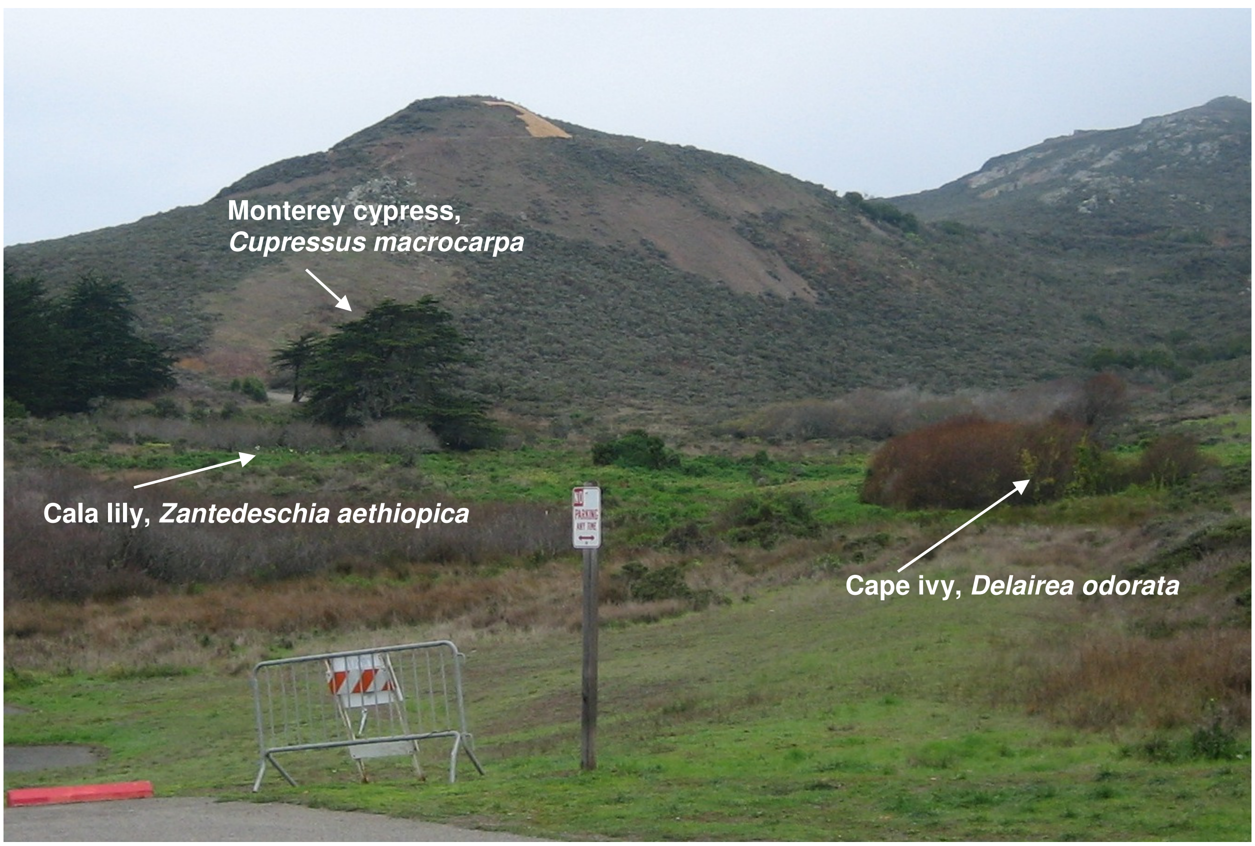

Figure 6. Many exotics are visible over 50 or 100m from a road or trail at the right time of year.

2.4 Creating Management Units

Since all invasive exotics are not yet in all park areas or habitat types, park units were analyzed by geographical subunits—in this case, subwatersheds—that allowed managers to identify and quantify baseline invasive plant information and sensitivity of resources to invasion. Previous

GIS Specialists at the parks drew subwatersheds, well prior to the inception of this protocol, by dividing CalWater watersheds into smaller, manageable areas based largely on topography. For this protocol, subwatersheds were characterized by number and degree of current infestations, risks of further infestation, priority of resources present, and other characteristics based on inventory information available and management priorities (see Section 2.5 and Appendix B). Surveys were then targeted for roads and trails in high-risk or high-priority subwatersheds, depending on available resources.

Existing exotics programs have often created subunits for their management areas. Such subunits tend to be small (seldom exceeding a few hundred acres), and boundaries may overlap. Since they are often not spatially discrete, or even mapped, data identified by subunit is spatially unreliable. Discussions with other resource managers and divisions should precede establishing new management area boundaries to determine whether subunits could be applicable to more than one purpose. For example, watershed rehabilitation staff may also use subwatersheds, or maintenance staff who assist on projects may want input on area codes that will be used for Maximo tracking (an asset-, time- and task-tracking program used by maintenance).

Subdividing subunits into areas, and areas into sites, and sites into subsites (or "patches") will be necessary for on-the-ground management, and may have already been done in parks with existing programs. Clarity, both in naming conventions and in establishing boundaries, is essential for tracking data over time, whether a patch of weeds or a survey site. Legacy data on past management must not be lost due to name changes or boundary alteration; using areas whose bounds are currently delimited and extents are marked, known, and stored in a common location (such as the park's corporate GIS) with appropriate metadata will help avoid loss of historic data on invasive plant management.

2.4.1 Using Subwatersheds as Management Units

Subwatershed boundaries are based on geologic features and are often more objective than other types of management units. Primary reasons for choosing subwatersheds included the presence of an existing subwatershed layer in the corporate GIS, the biological basis of subwatersheds (generally they run along a single aspect from slope base to ridge), their tiering into watersheds which are used by other biologists when considering other management issues (*e.g.*, species of concern), and GOGA's existing practice of tracking exotics work by subwatershed. Using subwatersheds for exotics monitoring makes biological sense: in addition to aquatic exotics, many terrestrial invasives follow drainage corridors, either through lightweight seeds following up-canyon winds, vegetative spread along creeks or downstream fragment dispersal, or seed deposit by frugivorous animals in much-utilized riparian habitats. Potential disadvantages to using subwatersheds include the fact that boundaries are not highly noticeable on the ground, that transportation routes (roads, trails) generally pass through several subwatersheds, and that people may have difficulty in using numeric subunits that lack a familiar reference name. Subwatersheds are also not of a standard size, and often span more than one habitat type, which may pose a problem in comparisons or in having large survey areas. Finally, the use of numerals as a primary reference can pose potential sorting problems unless tight protocols are used. Many of these prospective difficulties may be circumvented by giving descriptive names to the numbered subwatersheds (*e.g.*, Fort Cronkhite West for GOGA 7-1), and later assigning field-mapped infestations to the appropriate subwatershed in GIS through an intersect or clip function. For more general observations, such as those from casual observers or certain legacy data, follow-up searches may need to be conducted to ensure location information is of the quality necessary for inclusion.

2.4.2 Other Management Unit Types
Inventory and Monitoring staff also considered but rejected the following options in dividing parks into management units: landscape features, habitat type, and grid. A short description of each option follows.

Park units could have been divided based on landscape features. Roads, trails, waterways, rock outcrops, fences, and treelines have been used for centuries by people to delineate areas. Most of these features also function in invasion biology, and serve well as survey paths. Using landscape features to form subunits is not recommended, unless much of the park has already been so divided and documentation and GIS boundary coverages exist. Trails are often rerouted, fencelines deteriorate, and trees may fall or be cut down, limiting their utility as permanent boundary markers.

Parks could have been divided based on mapped vegetation type. Many exotics invade certain habitats preferentially, and searches may be targeted to fewer species. For more comprehensive surveys (*e.g.*, if a list of all plants seen was kept), fewer species would potentially be encountered. As with other subunits, boundaries are not highly noticeable on the ground, transportation routes (roads, trails) generally pass through several habitat types, and edges are often convoluted and change quickly (within 10-20 years) over time making them poor as standard search areas.

Parks could have been divided into standard search area sizes (grids). While statistically easier to deal with, grids do not function well in management, as they have no biological basis; grids are not identifiable on the ground; people may have difficulty in using numeric subunits that lack a familiar reference name; and roads and trails will pass through multiple grids. Prioritizing or stratifying grids may be more difficult, because a single grid cell may include multiple habitats, aspects, and confounding risk or priority factor types.

2.5 Prioritizing Management Units

2.5.1 Matrix Methods
We developed a ranking matrix containing information from three general areas: management priority, risk, and current level of infestation. Each piece of information has an associated confidence level. The ranking matrix for GOGA was run using data from GIS layers from parks and the Exotic Plant Management Team, and data from the Restoration Database and 1994 PORE-GOGA vegetation map accuracy assessment plots. A similar matrix was run in December 2006 with PORE data. Coverages containing information from three general areas were added to the project: management priority, risk, and current level of infestation. ArcView 3.3, GeoProcessing Wizard (copyright ESRI 1992-2002), and XTools (Oregon State, 1998 and 2001) were used to compile spatial data for analysis. Coverages of similar type (*e.g.*, all exotics

polygon files; or all roads, trails, fences, and powerlines) were combined using GeoProcessing "Merge themes together" into shapefiles and intersect files (GeoProcessing "Intersect two themes") were made for each using subwatersheds as the overlay. XTools "Update perimeter, area, acres, and length" was run for the non-point intersect files to add area or length of features within each subwatershed. The resulting *.dbf files from the intersected themes were imported into an Access database and analyzed. The January 2006 version of the GOGA "Work Performed" database, which stores vegetation management activity information, was mined for data on number of species and hours of work by subwatershed. Similar species were grouped into guilds (graminoid, herb, forb, shrub/subshrub, vine/groundcover, broom, thistle, and tree) for analysis. Results of queries from the Access database were exported to Excel for summary and presentation. A sample of elements appears below in Table 3; the full results take the form of long spreadsheets not easily or suitably viewed in printed form, and so are not included as an appendix but remain on electronic file with this protocol. More detailed methods, including files used, can be found in Appendix B.

Methods for PINN, EUON, and JOMU have not been finalized, as they lack similar data layers. Additionally, EUON and JOMU are small enough that survey stratification appear unnecessary. PINN surveys may focus on riparian surveys by I&M staff and trail surveys by in-park staff. Discussions are underway to determine appropriate overlap and ancillary data collection with the wetland protocol for PINN, which plans to survey stream and wetland habitat in 100-meter-long segments.

2.5.2 Matrix Elements

In-park only: All acreage percentages were based on the number of acres in the park (determined by subtracting "out of park" alliance acres from subwatershed acres and clipping vegetation map by park boundaries).

Roads, trails, powerlines and fencelines: Infrastructure lines were conservatively buffered at four feet to create an area.

Rare plants: Rare plant coverages were generally good, and were looked at for both number of taxa and total acres; percent of subwatershed acres that were rare plant acreages was used as the scoring factor.

Rare animals: Rare animal polygons over-estimated habitat due to unioning errors (a single area mapped multiple times not "collapsing" into one area, but counting as multiple areas) and large buffers, and included historic populations, so number of taxa was used instead of acres.

Vegetation map data: The 1994 PORE-GOGA vegetation map was used to determine exotic-dominated (*e.g*., California exotic annual grassland or Eucalyptus) and high- or low-risk alliances; accuracy assessment plots were used for scoring number of species per plot.

Species-specific exotics mapping: Invasives data from weed mapping presented a large problem: no negative data. Consequently, areas with no polygons might be infested. Additionally, overlapping coverages and lack of information about what was treated and what still exists made acreages unreliable. However, percent of area mapped as invasive was used as one of the ranking criteria, because lack of information/bad information (not mapped or mapped but treated) will both yield search time, either from a higher priority by invasives not having been mapped or from staff doing removal of invasives (treated but not mapped).

Exotics removal database: Number of guilds from work-performed database and staff time spent were also used as scoring items (staff time was not ranked and broken up into quarters; instead, subwatersheds that were in the mid-range were given an additional priority point, for the reason similar to the invasives mapping: areas receiving a great deal of staff attention do not need more search time; areas receiving no staff time may or may not be infested; those areas receiving small amounts of staff time are most likely to have few exotics).

Using guilds of exotics.
The use of guilds (see text) in analysis provides several benefits:

- smooths the range of species present (>100 in some areas)
- avoids double-counting from misidentifications (e.g. *Cortaderia selloana* for *C. jubata*) or generic identifications (e.g. *Cotoneaster sp.*)
- helps characterize the complexity of invasions (5 species from 5 guilds is different than 5 species from 2 guilds)

Table 3. A sample of subwatersheds and matrix elements (unranked). Elements were standardized by acreage of subwatershed in park, ranked, and given a score (generally -1, 0, or 1). Exceptions were number of rare animal taxa and hours of work performed. Rare plant and animal taxa scores were weighted for final rankings.

Sub-watershed	Total Acres	Acres in Park	Infra-struc-ture Acre	Acres of Rare Plants	# of Rare Ani-mal Taxa	Acres of Exotic Alliances	Acres of at-Risk Alliances	Map'd Inv. Acres	Hours Exotic Work-Per-formed	# Guilds Map'd	# Guilds Work-Perf.
PORE3-3	1,812.73	1,812.74	8.49	16.60	1	15.46	385.03		6	1	1
PORE3-7	2,412.33	1,760.77	10.84	0.03	1	45.97	298.00	0.08	42	3	1
PORE4-1	1,446.99	1,258.60	11.33	0.00	1	189.65	41.89	9.92	6	3	2
PORE5-10	1,447.23	1,447.28	12.60	5.58	1	293.09	1,025.00	84.59	443	4	2
PORE5-13	1,949.91	1,852.16	22.67	135.36	1	496.60	923.65	82.60	32	5	3
PORE5-14	1,416.23	1,333.89	20.10	81.33	1	756.87	521.71	22.16		2	
PORE5-2	1,121.51	1,121.51	4.14			49.62	280.99	20.62	74	3	1
PORE5-4	1,805.93	1,797.87	14.72	3.12	3	110.49	1,217.14	21.33	64	4	2
PORE5-5	2,289.17	2,283.75	17.04	84.17	2	188.16	1,411.60	19.00	268	4	4
PORE5-6	1,791.23	1,791.24	8.90	26.06	1	179.43	1,415.45	5.58	2,406	4	3
PORE5-7	1,741.57	1,741.57	13.90	26.28	1	585.38	1,065.60	14.88	54	2	2
PORE5-8	1,032.66	1,032.66	9.22	11.93	1	417.94	579.63	0.01	4	2	1

Subwatershed elements were ranked, and then grouped along the most natural breaks and assigned a score. Higher scores mean more risk or priority. For example, subwatersheds were put in order based on the percentage of acres at risk for invasion (veg map data). GOGA subwatersheds with 0-19.5% risk scored -1 risk (n=57); 21-59.5% scored 0 (n=40); 64-96.4% scored 1 (n=45). Total score was obtained by adding risk to weighted (2x) priority (rare plant score + rare animal score), and subwatersheds divided into high, significant, moderate, and low priority. Subwatersheds entirely outside the managed boundaries were excluded, and acreage in park was used to determine percentages at risk, invaded, *etc*.

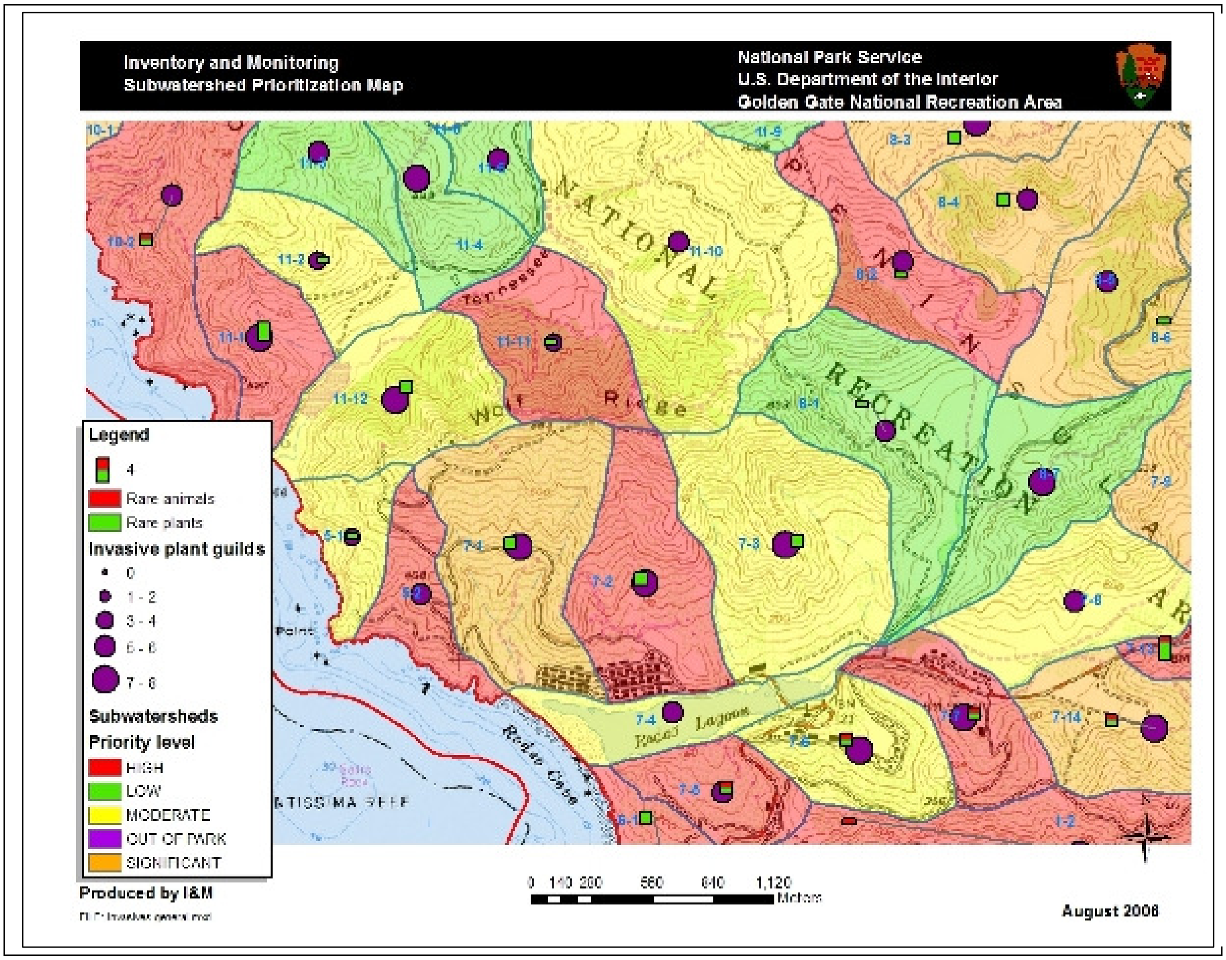

Figure 7. A map of prioritized subwatersheds in GOGA's western Marin Headlands (Fort Cronkhite, Rodeo Beach, and Wolf Ridge). Colors show priority level; three elements—rare plants and animals, and number of work-performed guilds—are also shown.

Confidence levels for matrix data were relatively uniformly low and did not factor into final rankings. Confidence will become more important with standardized data collection for exotics mapping, when age of data will likely be a driving factor in prioritizing search areas.

Suggested confidence levels are as follows:

1. High confidence: Knowledge is current and well-documented. Surveys are no more than two years old (for infestation level) and cover most of the management unit, landscape features (*e.g.*, buildings, trails, fencelines) noted are from a management document no more than ten years old.
2. Moderate confidence: Knowledge is slightly out-of-date or lacks good

documentation. Surveys are two to five years old, cover less than half of the management unit, or are based on anecdotal information from a good source. Landscape features are from an out-of-date document or are based on anecdotal information from a good source.

3. Low confidence: Knowledge is out-of-date and/or lacks documentation. Surveys are more than five years old, cover little of the management unit, or are based on poor sources. Landscape feature information is unsubstantiated.

2.6 Prioritizing Species

Concurrent to ranking management units, we ranked species to target for early detection based on the state of current knowledge. The list of species will change as the program proceeds due to introduction of new species, the potential establishment and expansion of previously "new" species, better understanding of species distributions, and the methodology used in monitoring due to changes in staff/volunteer/funding availability. The current list is somewhat iterative, in that a species must already be recognized as a weed to reach the highest priority levels (and therefore have spread beyond true region-wide "early detection"); future work will also look at adding more predictive methods based on regional work with BAEDN and searching invasives lists from areas with biogeographical similarity.

I&M staff did the following in 2006 for GOGA and PORE:

1. Reviewed the park datasets (NPSpecies, other plant lists) and compiled a list of all exotic species known or thought to occur in the parks (~300 species; see Appendix A). Removed known non-invasive species (*e.g*. not in Global Compendium of Weeds) or species locally non-native (*e.g.,* coast redwood (*Sequoia sempervirens*) in the Presidio); 174 species remained.

2. Noted which species were listed by the California Invasive Plant Council (Cal-IPC). Noted California Department of Food and Agriculture (CDFA) ratings, and whether The Nature Conservancy (TNC) has a completed element stewardship abstract for the species. Also noted if an unlisted species shared invasive characteristics with a congener.

3. Based on best available knowledge, noted if a species is an ecosystem alterer. Ecosystem alterers are those plants which affect a SYSTEM CHANGE, not just crowd out other plants: they change substrate composition or deposition, chemistry, or fire regimes.

4. Based on best available knowledge (reports, California Natural Diversity Database forms, manager knowledge), noted if a species endangers rare plants. Rare plant endangerers have been cited as crowding out rare plants in SFAN parks.

5. Based on best available knowledge, noted ease of control <u>independent of number of acres infested</u>. A high-level species is easily hand-pulled (or if shrub/tree will not resprout if cut), and has a slow spread rate; moderate is easily hand-pulled (or other non-chemical) but rapid spread, or will fragment if hand-pulled (coppice if cut), slow spread; low is hard to hand-pull

(fragments or coppices or has deep-seated roots), spreads quickly, is similar to nearby plants (*e.g.*, grasses).

6. Based on best available knowledge, noted feasibility of control based on number of acres, cost for removal, politics, and access. Levels used were low: >100 acres, or less but high cost (difficult access, specialized technique), politics against removal; medium: 25-100 acres, or less but high cost (difficult access, specialized technique), politics against removal; high: <25 acres, control straightforward, politics neutral or in favor of removal. Based "controllable" acreage on size of unit and annual area treated by exotics program.

7. Contacted the county Weed Management Areas (WMA) to determine what species are nearby but not yet in the management unit. The WMA will most likely have county-wide data, which may or may not be applicable to the unit.

Ease and feasibility of removal. Species can be easy to control, but still not feasible to control:

> Monterey pine (*Pinus radiata*) and Monterey cypress (*Cupressus macrocarpa*) are both invasive, but relatively **easy** to control—they take several years to reach reproductive age, and will not resprout when cut. However, these trees are **not feasible** for eradication: they are relatively widespread and charismatic, and some stands are considered historic—people often protest their removal, necessitating additional compliance (and raising removal budgets). Control activities for these species have no end point.

8. Contacted NPS staff in the area to find out what species they have noticed. People living and/or working nearby may have witnessed new infestations.

9. Visit local nurseries. Depending on the type of nursery and staff knowledge, the following data can be gathered:
   - What species they are selling as ornamentals that have the potential to become invasive.
   - What species the nursery staff is familiar with in the area that may be invasive.

Scores were assigned based on rankings, and then the list was sorted by feasibility of control. The overall list resulted in several levels of priority (Figure 8). Breaking the list into smaller chunks serves several purposes: new surveyors are introduced to a small number of the highest priority species, and can be progressively trained, while experienced observers can inventory a site for species on all lists; data collection can be restricted based on lower priority level; and the levels capture several types of early detection possibilities, such as species that are rare and invasive, new populations of widespread species, and species we know are present but do not know are invasive (yet).

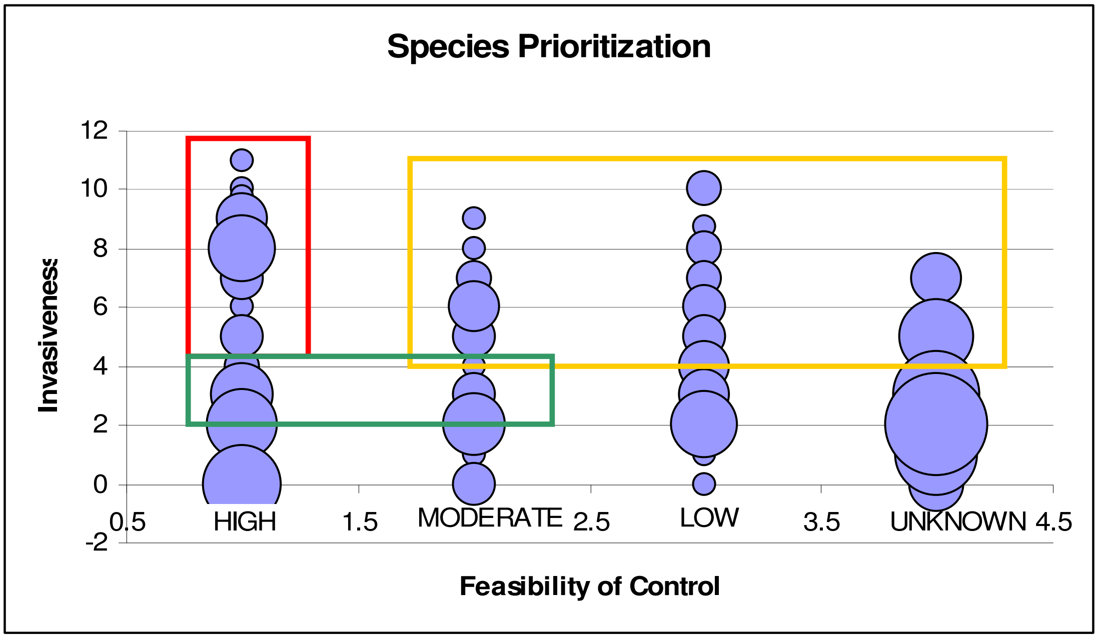

Figure 8. GOGA 2007 Priority 1 species (N=23; red box, upper left) scored high in invasiveness and high feasibility; Priority 2 species (N=29; yellow box, upper right) were highly invasive but lower feasibility, plus some species moderately invasive but high feasibility; Priority 3 species (N=31; green box, lower left) were moderately invasive and feasible; Priority 4 species (N=77; remaining species) scored at least one point for invasiveness. Some shifts were made based on difficulty of identification (e.g. grasses) and dune and aquatic species were segregated into a dedicated-search list. Size of dot represents number of species. See appendices for full species lists.

The list for PINN was run with similar data; an additional column was added and point given for species growing in riparian areas due to the high value of those rare habitats to the park.

2.7 Revising the Species List

Species lists should be reviewed annually for the first several years of data collection, and revised based on number of occurrences, acreages, and number of subwatersheds in which a species was found. The process, covered in the 2007 annual report, is summarized here: seven species found in more than 15 subwatersheds and with over 30 occurrences were shifted to List 3. One species had occurrences in 16 subwatersheds, but only 26 total occurrences, and was shifted from List 1 to List 2. Fifteen List 1 species had no occurrences; 13 were shifted to List 3.1, and two to List 5. Four List 2 species with few occurrences (found in less than five subwatersheds) were elevated to List 1; licorice plant (*Helichrysum petiolare*) was also elevated from List 2 to 1, even though its 10 occurrences were in six subwatersheds, due to its rapid spread rate and small occurrence size (most consisting of only one plant)—as well as its high priority for management in the park.

3.0 Survey Methods

SFAN parks vary greatly in the both the number and the abilities of early detection personnel available to them. Having a program that can adapt to different person-hours and skill levels allows parks to maximize their effectiveness. Engaging people in detection; giving them clear direction and a point person to answer questions and receive invasives reports; and following up with feedback on reports are essential components to a good program.The following section describes survey methods, scheduling, data management and data collection.

3.1 Opportunistic Sampling

The San Francisco Bay Area has one of the highest volunteerism rates in the country. Even in relatively remote areas of the parks, several aspects of a volunteer-based program can be used with interns, SCA's, or park staff and researchers. Every person working or recreating in a national park has the potential to serve as an early detector. Asking them to look, and giving them quality information on which to base their search, will get you quality information in return.

Observer Recruitment

Observers can come from a variety of sources, and each park unit must take responsibility for creatively recruiting help for the OS program to be effective. Observers can be from any skill level, as long as they have completed minimal training in the identification of top priority species. Observers consist of (but are not limited to) the following types of individuals:

- Interpreters leading hikes and disseminating information
- Rangers patrolling the backcountry
- Maintenance staff working at remote sites, road edges, and along trails
- Resource managers, research permittees and scientists working in the backcountry
- Park contractors
- Park leasees
- Special Use permittees
- Volunteer groups (especially Native Plant Societies)
- Educational groups
- Park partners

The flexibility of the Early Detection (ED) program at SFAN parks can accommodate all levels of botanical and technical expertise. Training modules for basic, intermediate, and expert levels are designed to provide the education and awareness needed to increase the number of opportunistic sampling (OS) reports. OS has been used nationwide to increase the chances of early detection of non-native plant species. Staff, researchers, visitors, and volunteers travel through the SFAN parks regularly. Each person is a potential set of eyes, an "observer," able to make field observations, with direction provided by SFAN. OS is based on providing observers with the tools needed to correctly identify top-priority weed species and document new populations with the highest level of accuracy possible and report this information back to parks. Information gathered from OS will be entered into the same database used for the entire early detection program, and identification and documentation materials are the same as the basic volunteer level. A primary difference between "passive" OS detection and "active" volunteer-based detection is the delineation of a search area. Active detection includes the search area so that area may have negative data (absence data) on species appropriate for the search level of the observer. Passive detection will likely only give you presences of priority species, which is still important information. In either case, having maps of different areas of the park with current infestations marked, along with "weeds to watch for" in those areas, will be useful for observers and allow you to gather useful data. If additional information is needed, staff should follow up with the OS reporter, and/or survey the areas reported to check species identification and search for more locations.

3.2 Revisit Schedules

For each park, the frequency of subwatershed visits will be determined by priority. The current plan is for roads and trails within high-priority subwatersheds to be surveyed annually, significant-priority surveyed biennially, moderate-priority surveyed within three years, and low-priority surveyed within five years; approximately 55% of subwatersheds would be visited each year. The survey schedule and timing recommendation can be found in Appendix C. Each survey rotation should occur during a different growing season to maximize detectability of different species. Although based loosely on revisit models from New Zealand (Harris *et al.* 2001), the revisit schedules in this protocol should be examined at the five-year data analysis point to determine if they are feasible given staffing levels and at appropriate frequency given observed spread rates and rapid-response capabilities.

3.3 Gathering Field Data

The primary directions and details on field data gathering may be found in SOP's 2 and 3. Surveyors should work in pairs and will usually cover no more than three to five miles of the project area per team per day, depending on target invasive plant densities, vegetation, and terrain. Mapping standards go beyond NAWMA basics to include guidance on how to draw the boundaries of plant patches based on biology and spatial distribution, and defining a threshold of $100m^2$ for the patch size considered early detection.

3.3.1 Naming Conventions

To improve data quality and tracking, staff use naming conventions and mapping standards. Search areas and weed occurrences have a similar descriptive code: name, subwatershed, and date are essential elements. The area code is SURVEYSUWAYYYYMMDDFILA, so a 1/23/06 survey in Subwatershed 7-1 by Andrea Williams would be SURVEY070120060123ANWI. The invasives mapping naming convention substitutes a GESPXX plant code (USDA PLANTS) for SURVEY, so if Andrea found jubata grass on her survey on 1/23/2006, she would code it COJU2X07012006012301, where the final two digits denotes the number of occurrence of this species on this day (first is 01, second 02, *etc.*). While such coding seems cumbersome, the use of this logic-based "what-where-when" naming convention incorporates a measure of data redundancy that can prevent user error. When combining data from several parks, the spatial tie will allow users to know which survey is for which park; since most aggregation will be for analysis, the lack of a park identifier in the name should not be a source of confusion.

3.3.2 Survey Data
Surveyors will record and enter *occurrence, assessment,* and *survey area* information, as well as track their route. The Project Manager or the Natural Resource Specialist will check survey results and entered information according to the Data Management section and SOP.

For the initial surveys, point *occurrences* and polygon *assessments* will be mapped for Priority 1 species; point *occurrences* and polygon *assessments* (if patch size is less than 100 m^2) for Priority 2 species; presence/absence, or point *occurrences* (if patch size is less than 100 m^2) for Priority 3 species; presence/absence recorded for lower-priority species (according to observer level), along with the *survey area*. For subsequent surveys most *occurrences* should already exist. EVERY mapping session (day/team) will include a new *survey area* based on tracklog information. Assessments also include ancillary data on habitat, phenology and distribution. Surveyors begin at a trailhead or other identifiable point, and continue along the trail until they need to get back. If a trail cannot be completed in a day, surveyors return to finish the area within the same phenological period. Generally, the time taken to map an area is more of a limiting factor than the time to hike; SFAN trails are not long. Trails which cross through more than one subwatershed are tracked under one *survey area*, named for the subwatershed which contains the longest section of trail. *Occurrences* and *assessments* are always named for the subwatershed in which they are found.

3.3.3 Negative Data
An important component of managing invasive species is knowing where they do NOT occur. Surveyors use track logs to note where they searched; this is buffered based on average sight distance to make a survey area. Species on the priority list of the observer's skill level that were not seen receive an "absent" listing in the survey area tab of the GeoWeed database. Advanced observers should be able to note all plant species seen within an area, at least to genus, and therefore have negative data for all other species. Such presence/absence data may not be appropriate for all purposes, as it tends to miss cryptic species, but invasive species are by definition not cryptic for long. If this is the first visit to a search area, the list must be compiled from field observations; future surveys can build off existing lists.

3.3.4 Collecting Specimens
Having a physical voucher of a plant, especially a potentially new record in the park, is still the preferred method of proving an observation. Specimens should not be collected by non-staff unless the individual has the proper Scientific Research and Collecting Permit. The GeoWeed database is unable to accept "unknown" as an identification, so a best guess and low confidence level should be used. Alternatively, location and description information may be written down and entered later. Volunteers and inexperienced observers should only take photographic vouchers of any unknown species. More experienced staff may field-key or choose to voucher for expert identification, or to record a new species for the park plant list or significant range expansion for an invasive species (*e.g.*, the first record in the county), but should also photograph the plant *in situ* to capture characteristics that may be lost during pressing. See SOP 4 for procedures and additional information.

Current staff available to serve as experts include Sue Fritzke, Maria Alvarez, and Michael

Chasse (GOGA, MUWO, FOPO, PRES), and Ellen Hamingson (PORE). When collecting for identification by a State Botanist, fill out a Pest Detection Report as directed (available from County Agriculture Departments).

4.0 Data Management and Reporting

This protocol follows the recommendations and standards put forth in the SFAN Data Management Plan (DMP, Version 2.0 2005). Only those items specific to this protocol, or so basic as to necessitate repetition, are included in this section. For more detail, refer to the DMP or to the SOPs (particularly SOP 5, Data Management) following this protocol narrative.

4.1 Database

This monitoring program utilizes the Sonoma Ecology Center's GeoWeed, which is based on The Nature Conservancy's Weed Information Management System (WIMS 2, TNC 2005). GeoWeed is an integrated system of hardware and software that works to simplify the collection and management of invasive plant data. The central piece of GeoWeed is the relational MS Access database ("the database") that works to keep track of all weed occurrences (documenting presence), assessments (monitoring), and all management treatments for weeds in a defined area. This database can be used in combination with ArcPad (the handheld version of ArcGIS) and a personal digital assistant with an attached GPS or a Windows-compatible GPS unit, like the Trimble GeoXT or Juno ST, or Thales Mobile Mapper CE. However, both spatial and non-spatial data can also be collected on paper and manually entered into the database.

GeoWeed is freely available online (http://geoweed.org), and is also used by network parks to track their weed work. The database was designed with data-sharing in mind, and exports data in NAWMA format to facilitate information transfer. The user manual is in production, but the current schema can be found in SOP 5, Data Management. In conceptualizing data repositories, staff had to consider both multiple parks combining data and multiple groups and organizations at a single park combining data. Not all organizations have access to NPS servers, but all may work in the same areas and need access to the same information. Staff weighed the benefits and drawbacks of a single back-end (data storage) database and multiple front-ends (user interface and entry), multiple front- and back-end databases with regular imports, and a web-based version. The configuration recommended for use at GOGA is a trio of back-end databases with multiple front-end databases, as well as an online access mainly for limited volunteer use. One database will be for GGNPC, one for PRES, and one for the remainder of GOGA and I&M. Data will be rolled up into a central database by I&M based on the below schedule.

4.2 Data Management

4.2.1 Data Entry, Verification, and Editing

Data downloads into the desktop database are recommended after every field day, and at a minimum after a field week. This allows the surveyor to detect any obvious errors and prevents data loss from battery failure or system corruption. Staff and expert-level volunteers will download from their own units; some moderate-level volunteers who collect data on GPS-PDA units may turn those units over to staff after their survey for downloading. Staff monthly checks of downloaded and entered data against paper data sheets help ensure the completeness and accuracy of data. All data sheets have a field for date and initials for data entry and verification. The database annotates when records have been changed. Occurrences from OS should be entered and the paper report (*e.g.*, a printed email) kept with data sheets.

4.2.2 Database Rollup and Data Exchange

Maintaining separate databases while providing for data sharing introduces unique data management challenges. Each site database must have its own manager to ensure data quality in preparation for data exchanges, make backups based on the frequency of data entry, and trouble-shoot for that database's users. PORE and PINN will only have one database each, and JOMU will not maintain a separate database, but GOGA will have at least three databases: one for I&M and Marin Headlands staff, one for Presidio (NPS and Trust) staff, and one for GGNPC staff. An additional database may be necessary for Site Stewardship. Monthly data exchanges are recommended: a “first Friday” data harvest of site databases into a master database with data from all parks, followed by creation of backup copies after data exchange. Previous versions of databases will be archived using the Archive button in GeoWeed and kept for six months, with one copy permanently archived at the end of each year. Archived versions will be named by date of archive (*e.g.*, GeoWeedData-GOGA_current-2008_12_15_12_16_39.zip is the GOGA data file of GeoWeed archived on December 15, 2008).

4.2.3 Survey Quality Assurance

Recommended observer quality checks include a full re-survey (soon enough to prevent identification confusion due to phenological changes) of one of ten surveys; if errors are found, a re-survey of a second survey of that observer is recommended; if no errors are found, re-survey one of every 20 surveys. Using duplicate, trained observers during a survey also increases confidence in data collected.

4.2.4 Annual Map Review

At the end of each calendar year, monitoring staff are responsible for reviewing mapping data accrued during the year. This review consists of:

- Assembling all information provided through invasive species work.
- Reviewing maps for completeness; maps without sufficient means of relocating the site must be deleted.
- Sorting information by type: paper maps; and coordinates, GPS data, or shapefiles.
- Comparing paper maps to existing GIS layers. Maps that show known populations and provide no new information will be discarded. Maps that provide new discoveries will be digitized into existing shapefiles.
- Reviewing coordinates, GPS data, or shapefiles; deleting data that does not show new information and filling in NAWMA-standard fields; adding new data to existing shapefiles. Every effort will be made to incorporate all information into GeoWeed.

4.2.5 Metadata Procedures

Data are collected year-round for invasive species, and data collection is never “finished.” Metadata in compliance with current NPS standards will be posted to the NR-GIS Datastore for the GeoWeed database by the invasive species early detection Program Manager in coordination with the SFAN Data Manager, but actual data will not.

Spatial data products associated with this protocol will be placed in annual reports, which will be catalogued in NatureBib, the NPS's on-line natural resource bibliographic database.

4.2.6 Data Archival Procedures

Electronic files will be maintained on the Inventory & Monitoring server within the file structure noted in SOP 5. Paper data sheets and annotated maps will be kept in the I&M office for three years, then archived in individual park archives with reference copies kept in the office.

4.2.7 Data Analyses

Data shall be reviewed annually for summary reporting, and every five years for analyzing patterns of invasion and subwatershed priority ranking. Since the data collected are simple, few calculations are needed before summarizing and reporting. A check with local land managers, online databases, collected data, and park staff annually or as needed will drive revisions to priority species lists. As additional quality and estimation checks, comparisons between projected and actual rapid response, and projected and actual survey miles, can be run.

Every five years, a trend and synthesis report will be produced. This report will include trend information by species and location, synthesis of invasive species data with habitat and management information, as well as analyses to improve and refine the program, such as an update to the matrix to refine the list of priority subwatersheds and species and examinations of revisit schedules.

More information about analyses is presented in SOP 5: Data Management, Analyses, and Reporting.

4.3 Reporting

Data acquired from surveys may be time sensitive. Acting upon new detections of highly invasive species is critical, therefore a feedback loop between monitoring and treatment programs must be established. On a monthly basis, new detection monitoring reports will be submitted to the local park weed manager. These reports will include both newly discovered species and newly discovered infestations.

On an annual basis, the monitoring coordinator will meet with local park weed managers to review the program, provide and receive feedback, and make program adjustments as necessary. Information from the parks regarding management can be gleaned from GeoWeed, the common database used to record occurrence and treatment information for invasive plant infestations. In addition to reports which include number of occurrences by subwatershed and by species, and the time spent surveying and miles covered; maps of locations and presence/absence of species by subwatershed will be prepared for annual reports.

Outreach and collaboration are essential to this protocol; additional products for non-vegetation staff and the public include presentations and trainings on priority invasive species; lists with photographs of invasive plants found during surveys; and articles for publications such as "Noxious Times," "Cal-IPC News," "Park Science," or "Fremontia."

Long-term trend reporting will focus on trends in species distributions: spread rates by habitat type or subwatershed and trends in number of detections. Most long-term trend information for invasive plant species will be captured and reported under a separate protocol.

More information about reporting, including outlines of monthly, annual, and other reports can be found in SOP 5: Data Management, Analyses, and Reporting.

4.4 Revising the Protocol

This protocol is a living document, designed to capture current best-laid plans in a readily disseminated and followed format. Changes and revisions will inevitably be made, and documented in the Change History logs at the beginning of this document and each appendix (as applicable) and SOP. Minor changes, such as an alteration of species lists, will be recorded as decimal increases in version number (*e.g.*, Version 1.1 to 1.2). Major changes, such as an alteration in objectives or update after five-year analysis, will be recorded as integer increases in version number (*e.g.*, Version 1.2 to 2.0). Such changes may also trigger an additional peer-review process, which the Project Lead will coordinate with the I&M Coordinator. Prior versions will be stored according to SOP 1, Revising the Protocol; and new versions forwarded to protocol users.

5.0 Personnel Requirements and Training

5.1 Roles and Responsibilities

Natural Resource Specialist: The Term GS-09 Natural Resource Specialist (Inventory & Monitoring Biologist), subject-to-furlough, has primary responsibility for protocol development, refining, and overall quality assurance and reporting; she devotes approximately 0.5 FTE to invasive species early detection work. Her duties also include chairing the Vegetation Working Group and training and supervising two GS-06/07 (or equivalent) Biological Science Technicians. All positions have a flexible work schedule ("maxiflex") to accommodate irregular field hours and travel. The Natural Resource Specialist position requires moderate to high skill with plant identification, supervision, GIS/computers/databases, and writing; and moderate skill working with volunteers. The Natural Resource Specialist is supervised by the Network Coordinator; the Vegetation Working Group also has some input on her work plan.

Biological Technician (2): The GS-06/07 (or equivalent) Biological Science Technicians are term subject-to-furlough positions shared with their "home" parks: one at PORE, one at GOGA. These positions have day-to-day responsibility for leading volunteers, field data collection, and QA/QC. They also create maps, materials, and assist with reporting, and attend Vegetation Working Group meetings. They are the lead on volunteer recruitment and training, with assistance and input from the Natural Resource Specialist and home park resource staff. The Technicians should have moderate skill with plant identification, GIS/computers/databases, and supervising and working with volunteers. These position are projected to be 0.6 FTE based on budget scenarios, and over the long-term supervised by the invasive plant specialist at their home parks. At least twice a year, the two technicians will travel to PINN for early detection surveys.

Data Manager: The GS-11 Network Data Manager provides technical support to assist with data management, meta-data, and reporting. Most data management, data analyses, and reporting, however, are provided by the Natural Resources Specialist.

Network Coordinator: The GS-12 Network Coordinator provides programmatic support including project supervision and oversight. The coordinator is also responsible for reviewing annual reports, updates to the protocol, and trend reports.

The Vegetation Working Group, comprised of plant specialists from network parks, meets four to six times per year to give input and direction on vegetation-related vital signs. The group ensures integration of monitoring into management, provides suggestions for additional funding, and allows for increased inter-park collaboration and the free exchange of ideas and information.

The SFAN Vegetation Working Group:

- Natural Resource Specialist (Chair; Vacant) San Francisco Bay Area Network
- Jennifer Jordan, Lead Biological Technician San Francisco Bay Area Network
- Biological Technician (Seasonal) San Francisco Bay Area Network (PORE)
- Lorraine Parsons, Supervisory Ecologist Point Reyes National Seashore
- Ellen Hamingson, Restoration Biologist Point Reyes National Seashore

- Sue Fritzke, Supervisory Vegetation Ecologist Golden Gate National Recreation Area
- Maria Alvarez, Plant Ecologist Golden Gate National Recreation Area
- Marcus Koenen, I&M Coordinator San Francisco Bay Area Network
- Brent Johnson, Botanist Pinnacles National Monument

Occasional attendees:
- Dave Press, Lead Data Manager San Francisco Bay Area Network
- Marie Denn, Aquatic Ecologist Pacific West Region
- Bobbi Simpson, CA EPMT Liaison Biological Resources Division
- Alison Forrestel, Fire Ecologist Pacific West Region
- Michael Chasse, Natural Resource Specialist Golden Gate National Recreation Area

5.2 Volunteer Recruitment
Volunteer programs are most successful with a committed group, clear and consistent guidelines, and meaningful work (see, *e.g.*, **http://www.invasivespeciesinfo.gov/toolkit/detspot.shtml**). SFAN's most consistent volunteers came from other volunteer programs, and overall recruitment can be a slow process. The early detection program focuses outreach to college independent study programs and internships to get longer-term volunteers; investing in a few quality volunteers is more appropriate than the quantity-based programs useful in removal work.

See SOP 6 for volunteer position description and suggested recruiting methods.

5.3 Training
Informal trainings may happen as needed, but formal trainings are at the core of a volunteer-based program. Volunteer levels and required trainings from the pilot "Weed Watcher" program at GOGA can be found in SOP 3, Field Data Collection. Volunteers progress from learning the highest-priority species to identifying additional species, reading maps and mapping on paper, learning to take point and polygon data, and surveying without staff accompaniment.

SFAN volunteers are very involved in parks and have a good base level of plant recognition. Volunteers can already identify many problem species before formal training, which allows park staff to have such a large priority list (11 List 1, 11 List 2 at GOGA; see Weed Watcher forms in SOP 3). With areas where people do not know plants as well, lists should be smaller—no more than 10 plants. Avoid giving volunteers priority species they will rarely, if ever, see: if searches are never successful, the search image will fade. Volunteers may need to be trained to photograph unknown species for identification instead (see "Collecting Specimens" above and SOP 4).

Trainings for new staff will include an introduction to the GeoWeed database as well as the trainings on recognizing species and using the hand-held device that are given to advanced volunteers. The Natural Resouce Specialist will assess the botanical skills of staff through training hikes, as well as the data-checks included as regular QA/QC.

5.4 Volunteer Trail Assignments

After attending a training, the volunteers are encouraged to join as many weekly guided hikes as they would like. Once volunteers have attended enough guided surveys to feel confident in solo surveys, they have several options for choosing trails to survey. Some volunteers have trails they prefer to hike on, and will survey these trails throughout the year. Other volunteers will e-mail the park contact and ask for suggestions as to which trails need to be surveyed. The park contact will then refer to the schedule of trails to be surveyed to determine an appropriate trail.

6.0 Operational Requirements

6.1 Annual Workload and Field Schedule

While early detection can and should occur year-round, the volunteer-based season should have a break in it during which the time spent on volunteer recruitment, training and shepherding will be spent on summary reports and analysis. Peak survey season runs from March through June (Table 4); additional surveys later in the season will pick up late-summer and winter-blooming species such as *Dittrichia*. The Biological Science Technician should spend 60% of her time in the field, and 40% on data management, recruiting and training. After her season is over, the Natural Resource Specialist will continue limited surveys and data management, with most analyses and annual reporting done in winter.

Table 4. Annual work schedule for the early detection of invasive plant species.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Recruit Seasonal Staff												
Seasonal Staff												
Volunteer Recruitment & Training												
Volunteer Surveys												
Monthly Reports to Managers												
Annual Report												

6.2 Budget and Staffing Scenarios

While the program is designed for flexibility, the revisit schedule is based on an estimated number of miles staff and volunteers should be able to cover annually. GOGA, FOPO, MUWO and PRES have over 450 miles of roads and trails, not including social trails. PORE has almost 200 miles of roads and trails, PINN 45. EUON and JOMU have under 10 miles. A crew of two people should be able to inventory three miles of trail a day and have three field days a week, devoting the remaining time to training and data management. Surveys can be done year-round, with optimal visibility for different species during different seasons, so the maximum estimated coverage for one two-person crew is 351 miles. This is less than the approximated visit plan of 388 miles, based on the loose assumption that 55% of the subwatersheds means 55% of the trails. Some pay periods in summer are devoted to plant community change monitoring, so number of months and FTE fractions do not match exactly. Planned staffing for 2008 is as follows:

1. Natural Resource Specialist, GS-09, 0.5 FTE, year-round
2. Biological Science Technician, GS-07, 0.5 FTE, March-October (GOGA)
3. Biological Science Technician, GS-06, 0.4 FTE, April-August (PORE)

Personnel costs cover a GS-7 and 6 half-time (Table 5), seasonal (non-benefited) positions, and a portion of the GS-09 Natural Resource Specialist. Materials include costs for volunteer packets and ID cards, and are anticipated to reduce over time as personnel costs will increase. Vehicles include one for GOGA and PORE during the time technicians are on staff. Travel/Trainings covers local network travel, bridge tolls, and attendance at local trainings and the annual Cal-IPC symposium.

Table 5. Estimated budget.

Source of Funding or Expense	Budget	Expenses
I&M (Invasive Species)	$90,500	
Personnel 0.5 FTE GS-09/3		$35,000
Personnel 0.5 FTE GS-07/1		$27,000
Personnel 0.4 FTE GS-06/1		$18,000
Materials		$3,000
Vehicles		$5,500
Travel/Trainings		$2,000
Total	$90,500	
		$90,500

Recruiting and training volunteers and interns will be the shared responsibility of the Natural Resource Specialist and lead Biological Science Technician in the short-term. With interns and repeat volunteers, there should be sufficient personnel to meet the visit plan; however, volunteer effort can be irregular.

SFAN staff will continue to work closely with park staff on program implementation, especially rapid response. Currently, qualified surveyors may remove small populations if under a threshold size (*i.e.*, it would take less time to remove the plants than it would to hike back out to remove them later), but larger populations require rapid response commitments from parks. For true success of the early detection program, removal must be conducted within a certain period of time. Each park has committed to providing a certain number of hours of control work for newly detected populations, whether staff or EPMT hours, and parks and I&M staff will work together to look for additional funding sources for rapid response programs. I&M staff will assist in providing maps and data for grants and funding requests. Since grantors prefer eradication programs over ongoing control, these efforts should be relatively successful.

6.3 Equipment and Facility Needs

The program in SFAN parks has flexibility to accommodate various levels of equipment, from paper data sheets entered into a computer to a Windows-compatible field-rugged GPS unit synched to the database. Minimally, staff will need a computer with a full version of Microsoft Access installed (NPS computers may not have all service packs standard) to run the GeoWeed database, and ESRI ArcMap or ArcView. Staff will also need a regular phone line, so potential volunteers will be able to contact them. To use electronic field data collection, staff must have ArcPad 6.03 or higher (but not higher than 7.1), a personal digital assistant with an attached GPS or a Windows-compatible GPS unit, like the Trimble GeoXT or Juno ST, or Thales Mobile Mapper CE. To use GeoWeed, you must have imagery and files in WGS84. Use LizardTech's GeoExpress 6.0 or higher (Seattle, 2006) software to reproject Mr. SID Generation III imagery. The National Park Service has a number of floating licenses for GeoExpress; methods for reprojecting are on file.

6.4 Key Partnerships and Collaboration

As mentioned in Section 1.8, collaboration is key to early detection success. Inventory & Monitoring staff are working closely with network parks; attending Weed Management Area meetings; and working to build a Bay Area Early Detection Network with WMA's and state and Bay Area organizations such as the Bay Area Open Space Council's Stewardship Committee, the Association of Bay Area Governments, California Department of Food & Agriculture, Invasive Spartina Project, and Cal-IPC. Partially funded in FY08 through a Pulling Together Initiative grant and a Weed Management Area grant, BAEDN will function as a way to share protocols, methods, materials, and reporting; prioritize species on a regional level; and recruit and train early detection volunteers. The Golden Gate National Parks Conservancy has been another key partner, jointly hiring a technician, supporting GeoWeed development, and collaborating on methods development. Additional assistance may be available through these partnerships.

7.0 Glossary

The following glossary is partially adapted from Redwood National and State Parks' website, The Nature Conservancy's WIMS handbook, and the Center for Invasive Plant Management.

Areas: An *area* is a uniquely named parcel of land that may have either legally defined boundaries or locally derived place names. In this protocol we will use up to three *areas* to locate each *occurrence.* Two are predefined: the sub-watershed (*e.g*. Fort Mason is in GGNRA26-3) and the site name (*e.g*. Fort Mason, Milagra Ridge, etc.). The third *area*, the *survey area*, will be mapped and documented each day as a way of showing what area was surveyed, thus showing where target species were NOT found. Synonymous with *region* in GeoWeed.

Assessments: Surveys and monitoring of isolated weeds and weed population *occurrences* are defined and recorded in the database as individual *assessments*. An *assessment* therefore is a set of measurements taken over time, recorded for a specified weed *occurrence*. Each *assessment* relates to one specific *occurrence*, while each *occurrence* can accrue a series of *assessments* over time. An *assessment* for each *occurrence* can be recorded as a point, a line, or a polygon. *Assessments* will be used to depict the size, scale, and coverage of an occurrence and therefore will be used as a basis for monitoring the project's effectiveness. The initial *occurrence* and *assessment* data will serve as the baseline for the entire project area, and the project area will be re-assessed annually for the duration of the project. These periodic *assessments* will be used to determine if weed populations are increasing or decreasing in size and distribution and if *treatments* are having the desired effects.

Exotic: Occurring in a given place as a result of direct or indirect, deliberate or accidental actions by humans. Synonyms: alien, introduced, non-native, and non-indigenous.

Invasive: Tending to spread, intrude, or encroach, usually aggressively and in a hurtful manner. Gardeners characterize cultivated plants as "invasive" when they spread aggressively beyond where they were intended to remain, particularly if they outcompete and displace other plants in the garden. Native species can behave invasively, but this term generally connotes non-natives which can spread into undisturbed ecosystems.

Invasive species: Official term for an exotic species whose introduction can cause economic or environmental harm or harm to human health. The term originated in Presidential Executive Order 13112 issued February 3, 1999.

IPP: Invasive Plant Patrol. Early detection program implemented at Golden Gate National Recreation Area.

Management units: Areas to be monitored for new species/infestations. A management unit may be the entire park, critical habitat within a park, or areas of concern given their proximity to known entry points. Some parks define areas by watershed, others use site names–both are considered a management unit.

Occurrences: The weed *occurrence* is the basic unit of mapping and assessing a singular weed or weed population/infestation within WIMS and GeoWeed. Each *occurrence* defines the presence of a single species and is recorded at a specific location. The *occurrence* location is recorded as a point in space, although each *occurrence* may actually be a population of plants covering an extensive area.

SOP: Standard Operating Procedures. These are the detailed steps explaining how to carry out the monitoring protocol.

Treatments: A *treatment* is any weed management activity that occurs at a specific time over a defined geographical area. One *treatment* may affect one or more *occurrences* (of one or several species) over one or more *areas*. The WIMS and GeoWeed databases track all types of weed control methods, including manual and mechanical methods, prescribed fire, grazing, biological control, and any chemical treatments. The database also keeps track of how much staff and/or volunteer time has been spent controlling weeds.

Weed: A weed is a plant out of place. This term is subjective; a weed is not necessarily an exotic species, although the terms are growing more synonymous. The term "noxious weed" is an official designation for weeds which cause major economic harm. Plants introduced for their ornamental, utilitarian, or food value which "escape" and disrupt natural ecosystems have only recently been recognized as weeds. More precise, accepted, and general terms for environmentally harmful non-natives are exotic pest plant (although "pest" has a legal definition of causing harm, similar to "noxious") and invasive plant species. In Australia, exotic pest plants are termed environmental weeds.

Wildland-Urban (or Wildland/Urban) Interface (WUI): A term borrowed from wildland fire management, WUI refers to the area where homes and wildlands meet. WUI areas are more likely to have escaped ornamentals from homesites. Although fire WUI is generally less than 500 meters (more often 20-60 meters) around a community, the exotics WUI should be up to 3 kilometers based on maximal travel of wind-dispersed species. WUI should include park buildings if they have been landscaped with exotics.

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Standard Operating Procedure (SOP) 1: Protocol Revision Log. Version 1.4 (May 2009)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	March. 2007	Williams, A.	Adapted from approved WQ Protocol	Is for ED Protocol	1.0
1.0	May 2008	Koenen, M. and Williams, A.	Formatting	Conform to NRTR recommendations	1.1
1.1	January-March 2009	Williams, A.	Add reviewer comments and responses/changes made	Document and summarize comments and revisions	1.2
1.2	May 2009	Williams, A.	Add reviewer comments and responses/changes made	Document and summarize comments and revisions	1.3
1.4	July 2009	Koenen, M.	Add reviewer comments and responses/changes made.	Document and summarize comments and revisions	1.4

Contents

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1.0 Scope and Application

This Standard Operating Procedure explains how to make changes to the Invasive Species Early Detection Protocol and accompanying SOPs, and explains procedures for tracking these changes. SFAN or park staff editing the Protocol Narrative or any SOP need to follow this procedure to eliminate confusion in data collection and analysis methods. All SFAN vegetation staff should be familiar with this SOP in order to identify and use the most current methodologies.

This SOP also contains a table listing the most current version of the protocol narrative and each of the SOP's. This will provide a single reference for ensuring that the most current documents are being used. Also included is a section containing comments from protocol review, responses to those comments and approvals.

2.0 Protocol Revision Procedures

1. The Invasive Species Early Detection Protocol Narrative and accompanying SOP's are a living document, designed to capture current best-laid plans in a readily disseminated and followed format. Changes and revisions will inevitably be made, and documented as soon as they are deemed necessary and appropriate reviews conducted.

2. All edits will be reviewed for grammatical and technical accuracy and overall clarity. Minor changes or additions to existing methods will be reviewed "in-house" by the SFAN vegetation working group and other appropriate network staff. However, if a complete change in methods is anticipated, then an outside review is required. Subject matter experts familiar with invasive species monitoring and data analysis will be utilized as reviewers.

3. Edits and protocol revisions will be documented in the Revision History Log that accompanies the Protocol Narrative and each SOP. Only changes in the Protocol Narrative or specific SOP that has been edited will be logged. Minor changes, such as an alteration of species lists, will be recorded as decimal increases in version number (*e.g.*, Version 1.1 to 1.2). Major changes, such as an alteration in objectives or update after five-year analysis, will be recorded as integer increases in version number (*e.g.*, Version 1.2 to 2.0). "Record the previous version number, date of revision, author of the revision, identify paragraphs and pages where changes are made, and the reason for making the changes along with the new version number" (Peitz *et al*. 2002). Changes to conform to the most recent formatting required by NPS "Instructions to Authors" (NPS 2006) are generally done as part of protocol revision and not noted separately as changes.

4. Notify the SFAN Lead Data Manager or Project Manager of any changes to the Protocol Narrative or SOP so that the new version number can be incorporated in the Metadata of the GeoWeed database. The Data Manager or Project Manager will then edit the database per any changes to the Protocol Narrative and SOPs.

5. Post new versions on the internet and notify all individuals known to have a previous version of the Protocol Narrative or SOP.

6. When any significant changes in the data collection protocols occur, such as changes in sample collection techniques or equipment, a change in database, or changes in staff, there should be an "overlap" of methods and personnel (Oakley *et al*. 2003). This requires using both the old and new techniques on a given survey as well as having both the outgoing and new staff survey concurrently.

Table 1.1. Current SFAN Invasive Species Early Detection Protocol documents.

Document Name	Current Version	Version Date	Author
San Francisco Bay Area Network Invasive Species Early Detection Monitoring Protocol, Protocol Narrative	1.4	7/30/09	Williams, A.
SOP#1: Protocol Revision Log	1.4	7/30/09	Williams, A.
SOP#2: Mapping	1.3	6/5/09	Jordan, J. and A. Williams
SOP#3: Field Data Collection	1.2	6/15/09	Williams, A. and J. Jordan
SOP#4: Plant Collecting and Vouchering	1.1	5/8/08	Williams, A.
SOP#5: Data Management, Analyses, and Reporting	2.1	5/31/09	Williams, A., T. Philipi, and A. Forrestel
SOP#6: Volunteer Recruitment	1.1	5/8/08	Williams, A. and Speith, E.

3.0 Protocol Review

3.1 Reviewer Comments

Appendix SOP 1 A contains the PWR Protocol Review Checklist used by peer reviewers. Appendix SOP 1 B has the consolidated comments and responses from the writing team from the first round of reviews in September 2008. Appendix SOP 1 C has comments and responses from the April 2009 review. Appendix SOP 1 D has comments and responses from the July 2009 review.

4.0 Review Approval and Distribution

Key personnel involved with the development, implementation, and review of this monitoring protocol will be on the electronic mailing list for receipt of this document and subsequent major revisions. These include the following personnel:

- I&M Biologist/Nat. Res. Specialist (Vacant)   San Francisco Area Network
- Lorraine Parsons, Supv. Plant Ecologist   Point Reyes National Seashore
- Ellen Hamingson, Restoration Biologist   Point Reyes National Seashore

- Sue Fritzke, Supv. Plant Ecologist — Golden Gate National Recreation Area
- Maria Alvarez, Plant Ecologist — Golden Gate National Recreation Area
- Marie Denn, Aquatic Ecologist — Pacific West Region
- Marcus Koenen, I&M Coordinator — San Francisco Area Network
- Brent Johnson, Botanist — Pinnacles National Monument
- Dave Press, Lead Data Manager — San Francisco Area Network

5.0 Literature Cited:

Oakley, K. L., L. P. Thomas, and S. G. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 31: 1000-1003.

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Appendix SOP 1 A. PWR protocol review checklist.

Section 1	**Overall Organization and Presentation of Protocol Narrative**
	1. Is the overall monitoring protocol well-organized with sections clearly delineated?
	2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes.) Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendices recommended in the NPS standards published by Oakley et al. 2003 (http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf).
	3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, i.e. Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), etc. to allow for modular updates.)
	4. Are the tables and figures clearly labeled and understandable?
	5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder?
Section 2	**A. Background and Objectives (Chapter 1)**
	1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? Is the history and background for this resource issue well-referenced with supporting literature cited?
	2. Does the protocol narrative discuss the linkages between this and other monitoring projects?
	3. Does the protocol narrative describe how monitoring results will inform management decisions?
	4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked?
	5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions?
Section 3	**B. Sampling Design (Chapter 2)**
	1. Is there a clear and logical rationale for selecting the sampling design over others?
	2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.)
	2b. Has the target population or "sampling frame", and the sampling units, been identified? In other words, is the desired level of inference clear?
	3. Is the sampling frequency and replication identified?
	4. Is the timing of sampling defined?
	5. Are the location of sampling sites clearly identified?
	6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.)
Section 4	**C. Field Methods (Chapter 3)**
	1. Are preparations for the field season and equipment setup included? Are requirements for permitting and compliance discussed?
	2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? (Protocol variables and measurements may be discussed in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.)
	3. Is the method of access for sampling sites provided?
	4. Is there an overview of procedures for establishing, monumenting, and maintenance of

	plots discussed in one or more SOPs?
	5. Does the protocol include details for the post-collection processing of samples or vouchers?
	6. Does the protocol include procedures to be followed at the end of the field season?
Section 5	**D. Data Handling, Analysis and Reporting (Chapter 4)**
	1. Does the protocol provide an *overview* of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD's General Comments 15, and checklist items in Section 2, items 8-10, below.)
	2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.)
	3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design?
	4. Are there recommendations for routine data summaries and statistical analysis to detect change?
	5. Is there a recommended reporting schedule?
	6. Is there a recommended report format with examples of summary tables and figures?
	7. Is there a recommendation for long-term trend analysis (e.g. every 5 or 10 years)?
	8. Does the protocol narrative include an adequate description of metadata and data archival procedures?
	9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness?
Section 6	**E. Personnel Requirements and Training (Chapter 5)**
	1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications?
	2. Does the protocol include a discussion of training procedures for personnel?
Section 7	**F. Operational Requirements (Chapter 6)**
	1. Are facility, vehicle and equipment needs identified?
	2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable?
	3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included?
	4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? Does it seem reasonable?
	5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)?
Section 8	**G. Literature Cited (Chapter 7)**
	1. Are the literature citations relevant, sufficient and consistently formatted?
Section 9	**Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water Quality protocols, Part B Guidance or WRD's General Comments 15 should be consulted when developing SOPs.)**
	1. Is there a table of contents for the SOPs?
	2. Are changes to each SOP clearly identified with a title, version number **or** revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in

	the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, e.g. SOP 1.00, 1.01…
	3. Is there a SOP with instructions for revising the protocol and a revision history log?
	4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11 below.)
	5. Is there a SOP for training field personnel?
	6. Is there a SOP that clearly defines protocol variables and how to measure them? (See Checklist, Section 1C2.)
	7. Are there clear and detailed driving and other navigational instructions to sampling sites?
	8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency's STORET database?
NA	9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power – this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP?
NA	10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data?
NA	11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics?
	12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing?
	13. Are the literature citations with the SOP relevant, sufficient and consistently formatted?
Section 10	**Supplementary Materials or Appendices**
	1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol?
	2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible.
	3. Are data collection forms provided either in this section or in an SOP?
	4. Is there a section for the Administrative Record that provides the history of protocol development and refinement? (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.)

Appendix SOP 1 B. Protocol review comments from September 2008 review, and how they were addressed.

Author's response to comments will appear in italicized font to distinguish from reviewer comments.

UNIVERSITY OF WASHINGTON

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University of Washington, Seattle, Washington 98195

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September 28, 2008

The scientific review for "Early Detection Monitoring of Invasive Plant Species Protocol in the San Francisco Bay Area Network" is complete. This protocol, like other invasive species protocols submitted by other networks, is organized around a "search and destroy" approach. No hypotheses and no real trend analysis (with appropriate power) are presented. Therefore, as a scientific monitoring protocol, it is not and will not be acceptable. In discussion with Pacific West Region I&M coordinator Dr. Penny Latham, it was decided that protocols involving early detection of invasive species, which focus on "search and destroy" techniques, would be reviewed as management protocols rather than monitoring protocols. It is under that definition that this protocol receives the following decision:

Acceptable with Minor Revision

Attached to this letter are review and informational documents: (1) a PWR Protocol Review Checklist. Each question is addressed in the left column; if scientific, it is addressed by me and the word (Yes, No, In Part, or N.A. [not applicable]) is in bold black font, and if administrative is addressed in regular font. Additional administrative comments are noted as AR. (2) The individual reviews are included, and one author asked to be specifically identified; in this summary document I will identify reviewers as R1 or R2 [my comments are PRC]. The reviews are self-explanatory, but what I attempt to do here is place them in an integrated context beyond the abbreviated response in the PWR Protocol Review Checklist.

Although reviewer comments are extensive, many are in the nature of comments rather than deficiencies that need attention. Among the more significant:

- Data analysis section is still pretty unclear (PRC 8-20/07 review, AR). This is the major weakness of the current draft, and must be addressed in detail.

Extensive revisions were made to the data management and analysis SOP, including delineating which types of data should be used for which analyses, and separating and noting the four basic *uses of the data: the immediate reporting of location to management; the periodic analysis of trends in species distribution and abundance; the correlation of invasive species populations with other data (habitat, disturbance, date, etc.); and the periodic analysis of data for protocol improvement.*

- Why are roads and trails a focus of survey when there is no evidence presented that these are the major vectors of spread (R1)? PRC commented on this in the first review (8/20/07): "The protocol limits the survey techniques to roads and trail corridors. The span of inference is therefore only roads and trail corridors, and the question as posed cannot be answered. What if, for example, a riparian zone was the main vector of spread for an invasive species? Only where the corridor crossed streams would that species possibly be detected, and it might show up as a minor invasive threat when in fact it was more widely spread. The fact that it was detected along a road or trail might lead one to conclude that the road or trail was the corridor of invasion." If the plant ecology protocol will definitively answer this question, then so state. If not, some preliminary survey would seem appropriate as a justification for the limitations of sampling locations.

References were added supporting the increased prevalence of invasive species near road and trail corridors. Additionally, the fact that over 10% of stream corridors in PORE, GOGA, and PINN are within one detection distance of a road or trail was added.

- The detections will be placed on a common "occurrences per length" metric, but because some species will be detectable at greater distances, is there a bias here? (R1)

Most metrics will be analyzed by species, as well as being lumped by guild or priority. Looking at occurrences per length through all three of these filters should reveal if a single species or type is skewing numbers. Additionally, a single species' detectability will remain similar over all occurrences, so unless occurrences of more-detectable species cluster it should not present a bias. In other words, a species that is more detectable than another will always be more detectable, and always more likely to be found, so if it drove up occurrence numbers it would do so in every location found. A more likely source of bias may be from plant community, which influences sight distance and therefore detection distance, so a species that can invade several habitat types may be found more often in a certain type—not because it is actually more prevalent, but because it is more apparent. The influence of plant community will also be analyzed multiple ways in the trend and synthesis report, as outlined in the data analysis SOP.

- Patch size may not be an adequate indicator of change (R2). While this may be unavoidable, please respond.

Patch size <u>is</u> a poor indicator of change; it will not be used for change detection. Rather, patch size helps define data collection and management response options. Change will be measured in several ways, but primarily through the number of occurrences and not the size of patches.

In the revision, please make sure you have addressed <u>all</u> comments of all reviewers. For response to comments not identifying deficiencies, a simple "we agree that this is appropriate" or similar response is adequate. We expect a revised protocol and a detailed document that specifically shows how each reviewer concern was addressed (or why it was not). With detailed attention to the revision process this management protocol will not require additional peer review. I hope these comments are of use in the revision, and I look forward to receiving a final revised protocol.

Sincerely,

James K. Agee
PWR Protocol Review Coordinator

Attachments: PWR Protocol Review Checklist, Reviewer comments

PWR PROTOCOL REVIEW CHECKLIST
Protocol Name: SFAN Invasives
Science Reviewer: **J.K. Agee** 9-28-08 Admin. Reviewer: D. Sarr 8-20-08

	Overall Organization and Presentation of Protocol Narrative
Yes	1. Is the overall monitoring protocol well-organized with sections clearly delineated?
Yes, There are fewer SOPs than recommended by Oakley et al. Partly because some SOPs combine procedures, and because some procedures are in the narrative.	2. Does the protocol have a title page with authors' names, protocol version number and date? (Protocol version numbers should be constructed to allow for both major and minor changes.) Is there a Table of Contents, abstract, and the three basic sections: 1-Narrative, 2-Standard Operating Procedures (SOPs), and 3-Supplementary Materials or Appendices recommended in the NPS standards published by Oakley et al. 2003 (http://science.nature.nps.gov/im/monitor/protocols/ProtocolGuidelines.pdf).
Yes.	3. Is there a complete and accurate table of contents with page numbers? (Chapters should be paginated consecutively, i.e. Chap. 1 (pp. 1-20), Chap. 2 (pp. 21-28), Chap. 3 (pp. 29-44), etc. to allow for modular updates.)
Figure 3 is fairly confusing. Figure 4 is hard to interpret-park names could be placed directly over graph rather than in title. I think it would be clearer to have figure legends wrap under photos rather than run across the entire page.	4. Are the tables and figures clearly labeled and understandable? *Figure 3 is meant to show the often-confusing and convoluted nature of data-sharing within GOGA.* *Suggested changes were made to Figure 4 and photo legends.*
Yes	5. Is the protocol bound so that it lies flat, preferably in a 3-ring binder?
Section 1	**A. Background and Objectives (Chapter 1)**
Yes	1. Does the protocol narrative provide a rationale or justification for why a particular resource or resource issue was selected for monitoring? Is the history and background for this resource issue well-referenced with supporting literature cited?
Yes, it provides a quite good context within regional efforts, but only briefly describes other SFAN monitoring efforts.	2. Does the protocol narrative discuss the linkages between this and other monitoring projects?
Yes, briefly	3. Does the protocol narrative describe how monitoring results will inform management decisions?
There are objectives related to reporting findings to managers,	4. Does the protocol narrative contain careful documentation of the monitoring objectives or monitoring questions being asked?

and to the use of volunteers that are unstated.	*Reporting information is a general objective to all protocols, and is delineated in SOP 5. Using volunteers, like hiring staff, is a means to implementation and not an objective in itself.*
Not exactly. It specifies how many subwatersheds of high, moderate and low priority should be sampled annually based on their management significance.	5. Does the protocol narrative identify specific measurable objectives such as thresholds or trigger points for management actions?
Section 1	**B. Sampling Design (Chapter 2)**
The pros of using volunteers are discussed, but not the cons (e.g., data reliability). We are also not sure what rationale was used with the revisit schedule.	1. Is there a clear and logical rationale for selecting the sampling design over others? *Some additions were made to the training section to discuss the use of volunteers. The revisit schedule is based loosely on models from New Zealand, as discussed in the text. A potentially overly frequent revisit schedule is currently in place, both to get better baseline data and enough information to analyze at the five-year point for revising the revisit schedule.*
Yes	2a. Were the criteria for site selection clearly discussed including stratification, spatial design, and whether this monitoring will be co-located and/or integrated with other VS monitoring protocols? (See Checklist, Section 1A2.)
Yes for species and spatial units, but level of inference is unclear.	2b. Has the target population or “sampling frame”, and the sampling units, been identified? In other words, is the desired level of inference clear? *The level of inference is limited to within the sight distance of the survey path for negative data, as described in Section 2.1*
Yes for units, but it is not certain whether all roads and trails of each subwatershed would be sampled each visit.	3. Is the sampling frequency and replication identified? *If roads and trails can be sampled in one visit, they will. Otherwise an additional visit is needed.*
It is defined to be variable (different seasons). This maximizes temporal coverage, helping ensure species are sampled when most visible. However, this introduces trend analysis issues (perceived trend may be due to changes in detectability).	4. Is the timing of sampling defined?

There are no maps showing the roads and trails. This would help illustrate how extensive the road and trail networks are..	5. Are the location of sampling sites clearly identified? *Appendix C has maps of subwatershed priority with roads and trails. Detailed (1:10,000) maps are also now available online (and at each park), but are not included with the protocol as there are over 100 for each park.*
No, but OK for management protocol	6. Is the level of change that can be detected for the amount or type of sampling being instituted identified? (See Checklist, Section 1A5.)
Section 1	**C. Field Methods (Chapter 3)**
No preparations are described, the work would be ongoing. There do not appear to be any permitting or compliance issues.	1. Are preparations for the field season and equipment setup included? Are requirements for permitting and compliance discussed?
Yes.	2. Does the protocol include clear and detailed information on taking measurements with example survey forms included? (Protocol variables and measurements may be discussed in detail in a SOP. A complete set of forms should be included in either the supplementary materials or a SOP.)
Volunteers may need to work with park staff in some cases.	3. Is the method of access for sampling sites provided?
Not applicable	4. Is there an overview of procedures for establishing, monumenting, and maintenance of plots discussed in one or more SOPs?
Yes	5. Does the protocol include details for the post-collection processing of samples or vouchers?
There is no end of season described. Program is year round.	6. Does the protocol include procedures to be followed at the end of the field season?
Section 1	**D. Data Handling, Analysis and Reporting (Chapter 4)**
Yes. May not be as detailed as it could be.	1. Does the protocol provide an *overview* of the process for entering, editing, and storing data, identification of database software, and whether the database is consistent with the recommended I&M database template structure? (For water quality protocols, see specific water quality guidance in Part B or WRD's General Comments 15, and checklist items in Section 2, items 8-10, below.)
Yes, but see R2 comments	2. Are quality assurance (QA) and quality control (QC) procedures presented for the various levels of data collection and analysis? (See water quality Part B guidance or General Comments 15 as appropriate.)
Yes, an overview. I am not sure if this section is sufficient. Figure 2 in SOP 5 seems very detailed, but is hard to digest.	3. Is the data structure clearly presented and sufficient to capture the required information to meet the stated goal? Is there an overview of the database design? *The figure was added at the recommendation of the SFAN Data Manager; references to additional documentation of the database are in the text.*
Insufficient, see PRC comments!!	4. Are there recommendations for routine data summaries and statistical analysis to detect change?

	The responses are below, with PRC comments.
Yes	5. Is there a recommended reporting schedule?
Yes	6. Is there a recommended report format with examples of summary tables and figures?
Yes, but insufficient detail (see #4)	7. Is there a recommendation for long-term trend analysis (e.g. every 5 or 10 years)?
<u>Yes</u>	8. Does the protocol narrative include an adequate description of metadata and data archival procedures?
Yes, at least for review.	9. Does the protocol narrative describe the frequency of testing and review of protocol effectiveness?
Section 1	**E. Personnel Requirements and Training (Chapter 5)**
Yes	1. Does the narrative include a listing of the personnel and describe their roles and responsibilities, and qualifications?
Only for volunteers	2. Does the protocol include a discussion of training procedures for personnel? *The procedures for staff are similar for volunteers; this has been clarified in the text.*
Section 1	**F. Operational Requirements (Chapter 6)**
Yes	1. Are facility, vehicle and equipment needs identified?
Yes	2. Is there a summary of key partnerships with agencies, organizations and individuals that are part of the monitoring program and a description of their contribution? Is there a list of relevant cooperative agreements and other partnership agreements, if applicable?
Yes	3. Is a schedule for the annual fieldwork and administrative needs required to implement this protocol included?
<u>Yes</u>	4. Is there an overall budget that summarizes the annual and periodic costs of implementation of the protocol? Does it seem reasonable?
Yes	5. Does the staffing plan and budget demonstrate that adequate resources have been allocated to data management, analysis, and reporting activities (ca. 30% are recommended)?
Section 1	**G. Literature Cited (Chapter 7)**
Formatting is not consistent. Some first names spelled out, most are not. See PRC Comments	1. Are the literature citations relevant, sufficient and consistently formatted? *Fixed*.
Section 2	**Standard Operating Procedures (Selected essential SOPs in addition to those mentioned in the narrative outline are identified in the checklist below. For Water Quality protocols, Part B Guidance or WRD's General Comments 15 should be consulted when developing SOPs.)**
Listed in Main TOC	1. Is there a table of contents for the SOPs?
Yes	2. Are changes to each SOP clearly identified with a title, version number **or** revision date, and page numbers? Changes to protocol modules (Chapters or SOPs) should be reflected in the overall protocol version number and protocol revision history log either through a minor or major revision; however, you may also wish to develop a numbering scheme for SOPs, e.g. SOP 1.00, 1.01…
Yes	3. Is there a SOP with instructions for revising the protocol and a revision history log?
No. Field season is more or less continuous.	4. Is there a SOP with instructions for preparation before the field season? Is there a SOP with instructions for procedures and equipment storage during and after the field season? (Also see numbers 10 and 11 below.)

For volunteer training	5. Is there a SOP for training field personnel?
Yes	6. Is there a SOP that clearly defines protocol variables and how to measure them? (See Checklist, Section 1C2.)
No	7. Are there clear and detailed driving and other navigational instructions to sampling sites? *This was added to the maps and search schedule in Appendix D.*
Yes	8. Are the details of Data Management identified in one or more SOPs? Topics to be included are at minimum identified in Section 1D and may include customized data management routines. Specifically for water quality monitoring data, does the SOP specify how data will be reported to WRD for entry into the Environmental Protection Agency's STORET database?
Not Applicable	9. For water quality monitoring and other monitoring as appropriate, is there a quality control SOP associated with each protocol that adequately documents QC objectives for measurement sensitivity (detection limits), measurement precision, measurement systematic error (bias as percent recovery), data completeness (including adequacy of planned sample sizes and statistical power – this topic may be in the SOP on Sampling Design), and (if applicable for lab measurements only) blank control? Are instrument calibration details included either in the QC SOP or in a separate calibration SOP?
Not Applicable	10. For water quality protocols, is there a SOP that includes an explanation of how data comparability (a quality assurance basic) was considered in choosing which protocols and chemical labs to utilize? Do protocol SOPs contain enough field and lab method details to allow others to determine if data produced is comparable enough to other regional data sets to be considered credible by regulatory agencies interested in the data?
Not Applicable	11. Do aquatic protocol SOPs adequately describe the details of all Sampling Protocols (Field and Laboratory), as well as equipment needs and operation, sampling techniques, sample preservation and handling and logistics?
Tough question. Revising the prioritization for sub-watersheds and species would need be difficult without more instruction. An example of the data analysis would help. I think the SOP section could be more detailed.	12. Are all major procedures required for the protocol sufficiently explained? Are any SOPs missing? *The subwatershed prioritization process was added as Appendix B. More detailed data analysis instructions were added to SOP 5 (data analysis and reporting).*
Yes	13. Are the literature citations with the SOP relevant, sufficient and consistently formatted?
Section 3	**Supplementary Materials or Appendices**
Yes	1. Is there a table of contents with Section 3 – Supplementary Materials that clearly identifies the materials provided in this section of the protocol?
Yes	2. Are the supplementary materials relevant, sufficient and consistently presented? Consistent formatting is desirable, but not always possible.
Yes	3. Are data collection forms provided either in this section or in an SOP?
Yes	4. Is there a section for the Administrative Record that provides the history of protocol development and refinement? A summary event table is highly

	recommended in addition to the supporting materials required in the Protocol Review File Checklist, e.g. the initial study plan or protocol development summary, the results of protocol development studies, peer review comments and responses during the development phase, and/or any published protocol on which a major portion of the methodology included in this protocol is based. (The published protocol may be presented either in Section 2 or Section 3 depending upon its contribution to the current protocol.)

Additional AR (Admin) Comments on SFAN Network Invasive Species Protocol

1. With annual sampling of some subunits, there will be a lot of resampling the same infestations (unless control treatments took place in the intervening period). Changes could reflect differences in detectability at different times of year, or different mapping by surveyors.
2. The species area curve on page 8 should be a negative exponential relationship. (Note from PRC here: I don't agree with this 9fewer species with larger area?)
3. The plant species naming convention does not seem consistent with NPS guidelines. Use common name followed by scientific name in parentheses. After the first mention, the scientific name is not needed.
4. The word weed is often used instead of invasive.
5. High priority subwatersheds that will be sampled annually are juxtaposed with lower priority watersheds that will be sampled less frequently. I wonder about efficiency. One could sample many short segments of road or trail that end at a subwatershed boundary when it could be more efficient to continue sampling these roads or trails.
6. The Data Analysis Section (4.2.7) in the narrative is very unclear and laden with undefined and questionable terms (exploring r values…????). It could be substantially refined and depth and specific details added. The Data Analysis section in SOP 5 is likewise insufficient.
7. Additional annotations on the paper copy of the protocol will be provided to the protocol authors via mail.

1. Remapping is only done if information is inaccurate or has changed; this was added to SOP 2: Mapping for clarity.

2. I agree with PRC; even if the reviewer meant the number of species should reach an asymptote, I would disagree. If we added sample units at a discrete location, we would eventually "finish" finding species but adding acreage does not follow the same rule.

3. Changes were made to conform with NPS guidelines, except scientific names were kept in figure captions as well as main text.

4. True, I tend to vary my word choice with near-synonyms; also, the volunteer program was named "Weed Watchers" for alliterative catchiness.

5. The ability to sample a certain distance of trail is most often dictated by how many infestations need to be mapped. The surveyor must determine whether she can sample other portions in addition to the one slated for sampling during that trip.

6. These sections were altered as indicated at the beginning of this response section.

7. Annotations received via email and addressed; see next page.

Annotations on SFAN Invasives Protocol

Daniel A. Sarr - October, 2008

Page 2; Par. 2; Line 4….Invasive species…[statement is redundant with opening paragraph on page 1]
Sentence removed.

Page 2; Par. 3; Line 6: move trees to after (Eucalyptus globules)
Removed "trees" as it was redundant.

Page 7; Figure 3: Figure is a bit confusing, small iconic arrows are not very clear.
Figure 3 is meant to show the often-confusing and convoluted nature of data-sharing within GOGA.

Page 8; Figure 4: Park labels in the figure title are confusing. I would put them directly over the data series to make it easier.
Suggested changes were made to Figure 4 and photo legends.

Page 8; last line on page: Cite some of Dr. Karen Beard's work (Utah State) with invasives and disturbance history?
References were added, although not these.

Page 12; Par. 2; Line 3: Did SEC create a database structure or alter an existing one?
The text from the original has not been changed, as I find it rather clear: "Based on The Nature Conservancy's Weed Information Management System (WIMS), SEC altered WIMS to create a back-end and front-end database structure, strengthen referential integrity, and increase data-sharing capability."

Page 12; Par. 2; Line 5: Use common name to be consistent throughout.
Done.

Page 14; Par. 5; Line 5: Delete "spread and" in prevent spread and invasion of infested areas.
Done.

Page 17; Par. 4; Line 9-12: Various coverages….awkward wording.
Changed to "Coverages of similar type.".

Page 19; Par. 3; Line 6: "approximately quartered" seems odd. I would just say divided into….
Done.

Page 22; Box: If box were offset horizontally, it might seem a better parenthetical statement.
Done.

Page 23; Figure 8: Categories should increase from left to right.
Not done; I prefer it as it is.

Page 25; Par. 2; Line 5: rephrase “will get you”
Not done; I prefer it as it is.

Page 25; Par. 3; Line 3: typo.
Fixed.

Page 31; Par. 2, Line 2: Data are plural.
Fixed.

Page 31; Par. 3, Line 1: How are matrices run? A more precise verb is needed.
Paragraph altered to present refined five-year analysis categories..

Page 31; Par. 4, Line 4: Is invasion patch size the primary criterion. How about an assessment of vigor?
Paragraph removed. However, it should be noted that % cover is collected along with patch size, which would give as assessment of vigor. Further, in most instances, patch size is not a primary metric for change.

Page 31; Par. 4, Line 10: It is not clear what “exploring r values” means. Define.
Paragraph removed.

PRC Comments

The questions posed are in much better shape than the previous draft. However, the justification (beyond a simple that's where we're sampling) for roads and trails (versus riparian zones, for example, a well-known vector for alien spread) still is not there. I mentioned this in the august 20, 2007 review. Will the plant ecology protocol answer this question? If so, please state. *Clarifications and changes in response to these comments are elsewhere in the response.*

The analysis at 5 years is no clearer than it was in the first draft. Rationalizing that analysis techniques will change in 5 years is not acceptable as an "out". Please show in detail how ordination (and which one - McCune has many) will address the problems. I can't see even what the matrices will be, and both AR and R1 also feel left in the dark. <u>The protocol will not be acceptable without a detailed response</u>.

Minor comments:
[All fixed]

Narrative,

p14, last par. Dewey and Anderson rather than et al.

Narrative References: I did not see the following references cited in the text:
CDFA 2006
Elzinga et al. 1998
GGNRA 1999
Harris et al (first one) has surname out of order
TNC 2005
Oakley et al. 2003
PRNS 2003
PRNS and Babalis 2002.
Welch et al. 2007

SOP #2, p3 bullet 7: discrete

Reviewer #1 (R1)

Protocol Review: Early Detection Monitoring of Invasive Plant Species in the San Francisco Bay Area Network: A Volunteer-Based Approach

The authors propose to implement a protocol using staff and volunteers to conduct systematic surveys of roads and trails for new and/or small populations of potentially harmful exotic species in the San Francisco Bay Area Network of parks.

While it is clear that managers have their best opportunity to control an invasive species while its population is small, the challenges of identification and detection of such small populations in wildland landscapes for early detection and rapid response (EDRR) are considerable and costly. Thus the implementation of a volunteer-based approach as proposed by SFAN managers poses an attractive opportunity. The authors of the protocol proposed have done an admirable job of detailing many aspects of how such a protocol could be organized. Those are addressed below. First I would like to discuss some overarching issues.

1. The principle difficulty with the protocol proposed is the *ambiguity of objective.* It appears to be a hybrid between a protocol to detect new populations of expectedly rare but potentially dangerous invasive plants with the objective of local eradication (management protocol) and one to monitor the health of the park in terms of the distribution of new populations of invasive species (monitoring protocol). A protocol review with quite different objectives in mind is likely to be confusing.

   Because the methodology is more appropriate to a management protocol than to a monitoring protocol, the following review will assume that the protocol is for management. *As it is.*

2. *Pathways for invasives.* Roads and trails are an obvious place to begin any survey of novel populations. Foot and vehicular traffic may disperse seeds; the disturbance associated with trail maintenance provides opportunities for new populations to gain a foothold. Access for surveyors is good. However, an early detection protocol first should assess invasive threats to the parks to determine the best protocol for an EDRR strategy. Garden waste, mulch, seed and stock for restoration projects, horses and ungulates, and dispersal from private land all may present substantial sources of new populations that should be addressed in any scheme to detect new invasions. An initial review and survey should reveal the highest priority pathways for attention.

A valid point, but an initial survey is at this point an unfunded mandate. This protocol aims to gather the most data possible given limited resources and use that information to improve detections. Garden waste, nurseries, stables, and most private lands are found mostly near the roads that serve as search paths; cross-training and outreach to other vegetation staff will help in finding new infestations in heavily managed off-trail areas such as restoration sites.

3. *Adaptive management.* Where data are scant and the broad outlines of important patterns that might guide management are not well known, continuous assessment of management

actions should be incorporated into the protocol. Several questions come to mind: Do novel populations present a substantial threat to park integrity? Do they spread beyond the trail and roadsides? Can they be controlled as part of regular trail maintenance? What proportion of novel populations are likely to be detected close to trails? If the predominant dispersal modes for target exotic species are not by foot or vehicular traffic, then those species and populations will be missed and the data will yield a false sense of security. How well are priority habitats sampled by existing trails and roads? A case in point is the apparent vulnerability of riparian habitats to exotic species; this observation suggests that riparian habitats should be a high priority target for surveys.

Unfortunately, most of these questions may only be answered by proxy, or by allowing the populations to spread beyond the point of rapid response. By attempting to rank species by recognized invasiveness, we hope to target those that would spread and have impacts if left untreated, which hopefully they will not. Priority habitats are surveyed most frequently, as indicated in the protocol, sight distance is quite long in most areas, and landscape-level inference should come with the addition of plant community change data. The riparian issue was addressed above.

Background and Objectives: what are the ~~monitoring~~ management questions proposed?

a. **Background and history: describe the resource issue being addressed**
Invasive species constitute a substantial threat to the biological and ecosystem integrity of wildlands and to human use of parks and recreational areas. Management of widespread populations is costly, risks collateral damage to conservation values and often has low probability of success. Control of invasive species populations while small promises higher success rates and lower costs, although it does not reduce the need for management of established populations. However, identification and detection of small populations of rare species from among large numbers of exotic species in poorly accessible wildland areas poses a considerable challenge.

b. **What is the rationale for selecting this resource to ~~monitor~~ manage?**

The authors propose to monitor trails and roadsides for small populations of potentially invasive target plant species. Trails and roadsides often are dominated by exotic plant species because of high dispersal opportunity, disturbance frequency and resource availability. They are also easily accessible to surveyors. Data are needed to support the assumption that such sites constitute the predominant source of new invasives to the park. For example is there evidence that existing large populations of invasive species began along trails and roads? While high traffic levels are associated with a high incidence of invasive exotic species, other pathways should be evaluated as well.

This comment has been addressed above, in 2 and in Dr. Agee's letter.

c. **What are the measurable objectives.**

Surveys are designed to detect small populations of potentially invasive exotic species from among a list of priority taxa. Rapid attention to control will limit the spread of these species while control is still feasible.

Problem Statement/overarching question:

Where are new populations of invasive plant species becoming established along roads and trails in SFAN parks?

Sub-questions:

What are the features of road and trail corridors that make the best predictors for invasive species establishment?

Are invasive species spreading from roads and trails into sensitive or critical park habitats?

The overarching question and sub-questions are not framed as hypotheses and thus the design is not well constructed to test cause and effect or the relative importance of key variables. There does not appear to be provision for answering the 3rd question. The objective is to detect new populations of currently rare but potentially invasive exotic plant species.

What is the sampling design chosen?

From a list of known exotic species in the region, a priority target list is constructed taking into account such factors as presence in the parks, potential to cause ecological harm and/or threaten at-risk species, ease of control, and rate of spread. Park areas are subdivided into parcels termed sub-watersheds which are also ranked by management priority, risk and current infestation. The sampling design thus involves a set of rules determining which species are monitored and in what detail, what kind of information is recorded and by whom and which sub-watersheds are monitored and how often. Data are reviewed at regular intervals, distributed to managers for action, and the protocol revised as determined appropriate.

a. The rationale for the design and site selection, and replication in space and time, must be addressed.

The design, site selection and replication in space and time address several challenges to invasive species monitoring: Scarce resources in terms of both personnel and expertise limit the area surveyed, survey frequencies, the number of species targeted and the ability of the surveyor to detect and identify species of concern. Poor accessibility and visibility of target plants mean that surveys of open terrain will be slower and less complete than surveys of those adjacent to roads and trails. These realities mandate prioritization of both species and sample sites to make the best use of both experienced and inexperienced surveyors. This strategy should provide an early warning system for newly emergent invasive species, although it cannot be expected to expose all potentially dangerous newly invasive species in the parks. It makes good use of personnel with differing levels of expertise.

b. Site selection:

1. **Criteria for site selection: define the boundaries or "population" being sampled**.

The design provides a mechanism for the total survey of the SFAN parks every 5 years for a priority set of target exotic species. Park areas are subdivided into parcels termed sub-watersheds which are also ranked by management priority, risk and current infestation. High-priority sub-watersheds are surveyed annually; lower priority sub-watersheds are surveyed less frequently.

2. **Procedures for selecting sampling locations; stratification, spatial design.**

The following protocol is proposed: Park geographic information is used to identify watersheds which are then subdivided by an unspecified mechanism [Mechanism detailed now as an appendix] to provide sample units varying in size between 11 and 4200 acres. A matrix of information for each sub-watershed incorporates management priority, risk and current level of infestation using information on infrastructure (roads, trails, powerlines and fencelines), vegetation map data, exotic species map data when available and exotic removal efforts. Sub-watershed units are grouped according to breaks in the distribution of the scores and assigned scores of -1, 0 and 1. The resulting index is weighted by presence of rare plants or animals and the resulting scores divided into approximately 4 groups (high, significant, moderate and low priority for survey).

However sparse data on local conditions mean that confidence in the matrix information is low for GOGA, for which the protocol is initially being tested. Similar information for PINN, EUON and JOMU were not available so methods for those rankings have yet to be finalized. Thus managers are limited by information available which at this point is of low quality and not always available. In its absence I would suggest that they incorporate findings from the research literature suggesting correlates of exotic species diversity as a guide for survey priority. For example high resource areas are likely to be rich in both native and exotic species. These might be areas of locally high moisture availability or soil fertility. *[Unfortunately this information is not more readily available than other matrix information.]* Areas adjacent to nurseries, gardens, horticultural enterprises and the like are often areas of exotic plant escapes.

The authors are to be commended for attempting a spatially based sampling scheme by subdividing the parks into sub-watersheds. Such data provide a more powerful basis for evaluating management protocols or change in park condition over time than do isolated observations. However, it is not clear how the trailside surveys will translate into infestation estimates for the parcel. For example some species (e.g. broom) are visible from considerable distances and other species (e.g., grasses) must be identified up close. Are these estimates to be placed on a common per unit area basis? *Infestations will be lumped for a per-trailmile metric, as well as split by species, guild or priority and examined on a per-trailmile (as well as other) basis.*

c. Sampling frequency and replication.

Sampling frequency varies according to sub-watershed priority (annually, biennially, every 5 years). This seems a reasonable first approximation, especially since there is strong seasonal variation in visibility. Annual surveys at different times of the year in priority areas may provide the highest quality data. However, I suspect that such a schedule will be difficult to maintain given fluctuations in personnel and funds. *[And certainly the frequency may not be maintained if not borne out by results of the five-year analysis.]* The utility of such frequent surveys will also depend on the ability of the SFAN parks to respond to needs for control. If responses are routinely delayed then frequent surveys may not be necessary. In this case sub-watersheds are being considered less as replicates and more as an organizational tool to obtain a total survey. The utility of this approach should be addressed within the context of the management goals.

d. **Recommended number and location of sampling sites**.

See 2c above.

e. Recommended frequency and timing of sampling.

See 2c above.

f. Level of change that can be detected from the amount/type of sampling being instituted.

The protocol as designed will be more successful as a management tool than on in which resource change is monitored. One advantage of a volunteer-based system is that different levels of observer expertise can be accommodated (some species are easier to recognize than others). However, changes in the volunteer pool across years and seasons may mean that year-to-year data collection is uneven. *[The potential failings of monitoring which relies on an observer pool with high turnover is a problem which plagues biological monitoing in the government, largely due to seasonal staff changes. One can only rely on training and checks on new data collectors. By using volunteers, this protocol actually hopes to build a long-term pool of local enthusiasts which will remain relatively constant, and definitely more so than many seasonal positions.]* At the simplest level, presence/absence data will provide information at the sub-watershed level to be summarized parkwide as frequency of occurrence for the most recognizable species. Estimates of patch size or cover for some species and sub-watersheds would provide information on species spread. For how many species will the park have sufficient data to track changes in distribution or spread? *[The parks will be able to track distribution for approximately 50 species at each park, with varying degrees of detail. List 1 species will always have a point and polygon, so actual infested area may be calculated; List 2 species will always have a point, so number of infestations may be reliably tracked. List 3 and 4 species may not always be surveyed for, although it is hoped that expert observers will be able to survey every road and trail at least once within the five years, so presence and absence by subwatershed—a perfectly valid, if gross, metric for invasive species tracking—will be collected and presented in the five-year report.]* Moreover, assuming that detection of these populations will result in rapid control actions, repeated monitoring will be critical to determining frequency of revisits for control purposes, e.g. to control new germinants from the seedbank.

Are the methods proposed with that design appropriate?

The methods proposed for an early warning system are for the most part well designed. Considerable thought has gone into training of volunteers for different levels of responsibility, field data entry (including how to handle a variety of field conditions) and data management. If the information generated were used by managers to control the populations identified then spread from trail and road verges would be mitigated.

If the data are truly used to monitor populations of these potentially problematic species as a gauge on the health of the park, then I would be concerned about consistency of effort and completeness of the data collection. *[The plant community change data will be more used as a long-term gague of effects of invasives and the health of park communities; the dispersion of plots over the park landscape and depth of data collection proposed for these areas makes them more appropriate than a surveillance-based protocol such as this.]* The authors correctly identify the problem of negative information under such a program, that is, confidence that a species does not occur where it is not recorded. Confidence in negative information may be difficult to maintain where different cadres of volunteers search in different areas for different species in different years at different intensities.

What analytical techniques will be applied to the data and how often?

A power analysis is not included, largely because no hypotheses are proposed for testing. The authors propose to analyze the data on approximately a 5 year rotation using summary statistics (frequency and habitat of occurrence for target species) and multivariate analysis such as non-metric multidimensional scaling to examine environmental correlates of species distributions. However rare species (which we suppose the target species to be according to their selection criteria) provide little guidance on habitat patterns because absences carry no information. How often are encounters expected? Confidence levels for environmental data are currently low for the principle parks and non-existent for others. Is there a plan to improve this situation?
We can only hope to identify broad patterns in infestations—certain species found more often in certain habitat types, and certain habitat types invaded more than others—and agree that rare species (especially exotics at their establishment phase) do not provide good data for modeling, as absence in an area may be temporary and not due to insuitability. However, data for List 2 and 3 species may yeild more useable information. One can only analyze the five-year data with the stated caveats in mind. Frequency of encounters in large part dictates the level of data collected, so there is a broad range depending on species (from 0 to approximately 50% for some List 3 species). Confidence levels for environmental data will likely not improve, with the exception of invasive plant location data, unless further inventories are performed (updated vegetation map, rare species locations). Other parks (PINN, JOMU, EUON) will be surveyed without prioritization to begin with; JOMU and EUON are small enough to not warrant it, and PINN will be surveyed on a rotation determined by consultation with the park botanist to cover areas not currently visited by park staff regularly.

a. Describe metadata procedures.

SFAN will complete the NPS metadata profile to the extent possible using Dataset Catalog and MS Access. Metadata will be available on the NPS Data Store. Data are stored in Geo Weed and are available by request from the manager.

b. Provide an overview of database design.

Datafiles are managed in Geo Weed, a data management application created by Sonoma Ecology Center for logging and tracking weed infestations and management efforts. It can interface with ESRI ArcPad in the field to map infestations and note characteristics of the infestation. This information will be edited and reports written in MS Access. Entries are tied to the geographic point of reference for an infestation, allowing multiple entries to facilitate tracking the infestation over time. Here as well, the protocol is designed to facilitate management rather than to monitor a resource.

c. Describe procedures for data entry, verification and editing.

Data will be entered digitally in the field on one of a variety of hand held field computers as well as on paper to preserve a backup. Field data are uploaded at least once a week and checked against paper records monthly. QA/QC protocols are run periodically to catch outliers or inappropriate entries. Ten percent of the records are resurveyed by the project manager to verify field observations. Staff will collate and summarize data annually.

These procedures appear adequate for the task.

d. Describe routine data summary procedures and statistical analyses to detect change.

Analyses to detect change will consist of primarily of map comparisons accomplished at the end of each year. Monthly updates to managers will provide time-sensitive information on population spread. Little information is provided on techniques used to detect change, which does not appear to be the objective of the protocol.

e. Described methods for longer-term trend analysis (e.g., over 5-10 years).

Every 5 years the data will be summarized for trends in population spread, sub-watershed priority rankings, and priority species lists. These analyses are apparently simple comparisons in frequency of occurrence or infestation size by sub-watershed. Sub-watersheds will be compared by priority ranking to see whether differences exist in the vulnerability of different site types. However, the bases for the comparisons are not defined.

This has been clarified as described above.

This part of the proposal is weak for a proposal designed to monitor a resource in part because hypotheses are not well defined and because the objective of the protocol is to control new populations of potentially dangerous species rather than to monitor resource trends.

Reviewer #2 (R2)
Early Detection Monitoring of Invasive Plant Species in the San Francisco Bay Area Network: *A Volunteer-Based Approach*

General Comments
As a management protocol, this is a great plan for managing invasive species in Bay Area National Parks, for educating the public, and for continuing to incorporate the use of volunteers to rapidly detect new occurrences of invasive species. The prioritization of species for monitoring and management action is well thought out and makes use of research findings in invasion ecology.

I really liked the way this plan takes advantage of many local and state-wide resources and partnerships (CNPS, CAL-IPC, Cal-HIP, etc).

It is clear that a great deal of thought has gone into making this protocol plastic enough to weather different levels of funding and staffing. Also the systems for volunteer training and the level of confidence that can be generally associated with different training levels are great. One question I have is will you have the data you need (especially in years with minimal funding) to answer the important management questions:

1) How are management actions affecting the percent cover, density, and patch/ population size of invasive species?
2) To what extent are invasives displacing stands of native vegetation?
3) Are invasive management actions leading to recovery of native plant communities or replacement by other invasive species?
4) Is manual removal by volunteers a successful strategy for controlling Species X?

These are questions that will have to be answered by the park, with the exception of (2), which should be answerable using plant community change plots.

As you know, P/A data and opportunistic field data collection will not be adequate for establishing trend. *[P/A data and opportunistic data are useable to show invasion trends (e.g., Salo 2005; or the INVADERS database), just not trends in an individual population]*. Percent cover and patch size will be more helpful indicators for adaptive management. Ratio of percent cover by natives to invasives can be useful in discovering the displacement of stands of native vegetation by invasives. To establish trends you need to revisit the same occurrences (assessment) over several years to get an adequate number of data points. *These are questions that should be answerable using plant community change plots. Adaptive management as it relates to removal is the purview of the parks; adaptive management for this program will have more to do with refining searches, not changes in % cover.*

It sounds like by requiring priority species to be mapped using polygons in addition to points you will be able to get information on the % change in area of the patches. One concern is that after an occurrence has been sampled every year for five years, the patch size could be bigger but the population size, percent cover, and density of the invasive species could be smaller/ lower. Therefore, percent change in patch size, by itself, may not be an adequate indicator of change in your vital sign. *Where polygon data are collected, information on % cover is also collected. The implications of data collected on potential analyses is addressed in SOP 5, Section 4.1.*

When you perform management activities, it sounds like you record the date, species treated, the management technique used, and for manual removal efforts, the number of person hours spent on removal. Be sure that this information is spatially linked to your occurrence/ assessment, and if the whole polygon was not treated, then what portion of the area was treated (eg we removed Scotch Broom on 25 % of occurrence (give occurrence label) in the southwest quadrant of the polygon). *GeoWeed records all of this information, or rather allows for the recording of this information.*

It seems like some of the responsibility for establishing trends and answering key questions is being left to the Plant Community composition and change protocol. Because of this decision, which was made for ease of operations and efficient use of field staff, the Early Detection Monitoring plan is not a stand-alone monitoring protocol; its success will be linked to the successful collection of the Plant Community Composition and Change data. Is it possible that the goals for this vital sign could be different enough that you will not capture enough data on plots dominated by invasives to answer your management questions? *[It is possible that plant community change plots will give all zeroes for some priority early detection species (List 1, especially—those that are not widespread); however, there will likely be some exotics in most of the plots (if fire effects and vegetation mapping accuracy assessment plots are any indication). By revisiting plots and tracking frequency and native:exotic ratios we should be able to answer our questions for the larger landscape.]* Assuming the Plant Community Composition and Change plots will be randomly located, they will be less apt to violate assumptions of multivariate statistics. In this way, the two protocols could be very complementary. That was my plan all along. Is there a way to make sure that x% of Community Composition and Change plots are located in priority subwatersheds for the Invasive Species Monitoring Protocol? Is there some other way to improve the probability of capturing the data you need for Invasive species management through the Community Composition and Change protocol? *There are ways of ensuring a percentage of plant community change plots fall within priority subwatersheds, but I think it would be detrimental to the protocol to do so, especially since subwatershed rankings may change over time and plot locations should not. I see the plant community change protocol as measuring broad land health trends, of which the status and trends of invasive species is one. I would consider augmenting these plots with invasive plant population-specific monitoring (selecting a subset of populations of Species X found representing different aspects and topographic positions to measure in detail; or co-locating population-specific monitoring with plant community change plots, for example), but I think the parks are better-served through maximizing our efforts at plant community change and early detection as a whole.*

Since to establish trend you must revisit the same plot over time, I am also wondering how updates to the species list/ subwatershed priority will change the probability of a given occurrence being revisited, as this would be necessary to fulfill the requirements of a long-term monitoring protocol. *I think your consideration of "trend" is too narrow: this protocol is not meant primarily to measure trends in a single occurrence—although it may do so, of the occurrence remains on revisit—but in a species or guild across the landscape, and in the invasion level of a landscape unit.*

If QA is necessary to reduce variation between multiple observers for the purpose of accuracy and for data analyses, is it o.k. just to recommend that it be done rather than mandating it as part of the protocol? Will it really get done? To what extent is QA happening with your current protocol? *I'm not sure I understand this comment—to someone following the protocol, recommendation and mandate have the same weight: they can choose to follow it or not. QA currently takes the form of "hot checks" in that mostly it is the Natural Resource Specialist going on hikes with seasonal staff, and/or staff hiking with volunteers or other data collectors. This occurs at the approximate frequency detailed in the protocol (more often during beginning training).*

Trends in detection of individual species… Thinking aloud…One would expect that you will be more apt to detect species that are in your top tier for volunteer recognition than other invasive species. One would also expect that well-trained staff members are more likely to detect invasive species than new volunteers, and after that detection increases with increased search time and area covered. Plants are easier to detect and identify when in bloom. It makes sense that given the same search time, smaller patches might go undetected if visited in the wrong season, whereas larger patches might be detected either way, depending upon the species. And in your analysis you can block by training level and search time, so this sounds good. *OK.*
Data Analyses: In addition to PC-Ord type ordination, other multivariate analyses will be required to answer some of your management questions. JMP or similar software will be helpful in accomplishing this goal. Although I agree that software may improve or change by the time you are ready to assess trends, you should be able to anticipate which types of analyses you will need to answer your specific monitoring questions. *This section was altered as indicated above*.

I would consider adding a chart with specific monitoring question, protocol, data collected, and anticipated method of analysis. If there are specific monitoring questions that you hope will be addressed through the Plant Community Change protocol, you could include it in the table. Then you would feel confident that between the two protocols, you will be able to address your primary monitoring questions related to invasive species management. *The table was added; see Section 2.2, Table 2, in the protocol.*

Literature Cited:

Rice, P.M. . INVADERS Database System (http://invader.dbs.umt.edu). Division of Biological Sciences, University of Montana, Missoula, MT. Accessed February 26 2009.

*Salo, F. 2005. Red brome (*Bromus rubens *subsp.* madritensis*) in North America: possible modes for early introductions, subsequent spread. Biological Invasions 7: 165-180.*

Appendix SOP 2 C. Protocol review comments from April 2009 review, and how they were addressed.

Author's response to comments will appear in italicized font to distinguish from reviewer comments.

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April 1, 2009

The review for the revised "Early Detection Monitoring of Invasive Plant species in the San Francisco Bay Area Network" is complete. This review includes my comments and those of Dr. Penny Latham, and we both addressed scientific and administrative issues. This protocol receives the following decision:

Acceptable with Minor Revision

This is the same decision as was made for the first draft, for the reasons explained below. There was a good response to many comments made on the first draft. The narrative and SOPs read well and contain substantial detail. However, the network needs to address a number of issues.

This will be approved as a management protocol, not a monitoring protocol (see my September 28, 2008 letter), and this needs to be clearly stated. Make sure to address this both in the executive summary and the introduction. It could be clearly addressed in one or more of the following ways: By altering the title to "Early Detection of Invasive Plant Species in the San Francisco Bay Area Network *A Volunteer-Based Management Protocol*" or something similar; Change 2.1 to Management Questions; Change 2.4 to Creating Management Units; Change 2.4.1 to Using Subwatersheds as Management Units; Change 2.4.2 to Other Management Unit Types; Change 2.5 to Prioritizing Subwatersheds

I removed "Monitoring" from the title and added language to the executive summary and introduction. I believe that, to the audience for this protocol, adding or substituting "Management" for "Monitoring" will create confusion in some cases, as the protocol does not discuss invasive species management. Monitoring is the consistent, systematic, repeatable measurement of a variable or variables over time. While the lack of hypothesis-based questions, plots, and few quantitative measurements may make this not-science, it is still monitoring. I will call it a management protocol, but believe that to be a semantic distinction. I changed wording only where I felt it would not confuse readers who may take "management" to mean "control."

Appendix C. Protocol review comments from April 2009 review, and how they were addressed (continued).

1. The quality assurance for observers (p. 30) is adequate, but exactly how it will be managed is less clear. How will surveys by volunteers be tracked and managed? *Surveys by volunteers are entered into the GeoWeed database, which records the name and/or type of observer. They are tracked and managed as with other surveys. Tracklogs denoting survey routes are similarly separable by observer type and volunteer/intern surveys are generally displayed in a different color than staff surveys on results maps.*

2. The analysis section (SOP #5, pp. 19-20) has been redone but it makes less sense now than it did in the first draft (there was more of a general plan in the first draft). It's not clear what is being analyzed, how it is being analyzed, or what the results might look like. Like the first draft, the current version of the protocol says that methods will depend on the technology available 5 years from now. My comment on the last draft was that "Rationalizing that analysis techniques will change in five years is not acceptable as an "out"." And, because as noted below, the Natural Resources Specialist position is being eliminated, how can GS-6 and GS-7 technicians be expected to do the analysis without guidance? The protocol needs to lay out a specific analysis technique using technology available today. It might be best to create a small database inventing data from year 1-5 to show how the analysis would be done, and actually show results and interpretation. For example you might take 50 species and massage the data such that 10 are getting worse over time and (hopefully) 20 are declining, with the final 20 vacillating around no change. What type of analysis would identify the 10 that are worse and the 20 that are better, and how are the results interpreted? Are all 5 years of data used, or only years 1 and 5? Essentially what I'm asking is for a template showing for a simple case how status and trend will be interpreted. Who will be tasked with the 5-year analysis? *I do not consider it an "out," but a simple statement of fact. However, I have removed the sentence. With additional advice from other statisticians and ecologists, I have made the section more detailed and laid out a generalized linear mixed model to examine trends in number of occurrences.*

3. The budget and text (p 33) indicates that the Natural Resources Specialist position will be phased out. While this in and of itself does not make or break the approval process, it does bring into play whether this management protocol can be continued as designed, particularly the QA and analysis functions mentioned above. SOP #5 notes that the Specialist will review annual and trend reports, but there will not be a Specialist around to do this, according to the current draft. Someone who *will* be around needs to be tasked with this effort. This is a question that the network needs to address in the response. *Plans are now to keep the Specialist, so the second staffing scenario was removed.*

4. The issue of riparian areas acting as vectors for invasives is better described than in the first draft. It is understandable that volunteers may not be capable of off-trail monitoring of invasives, but if riparian areas are to be excluded, then this needs to be made clear. Right now, page 18 states that I&M staff "may" focus on riparian surveys while park staff will focus on trail surveys. There is no description or discussion of riparian surveys in this protocol. The authors need to make clear that the existing protocol is not sufficient

for surveying riparian areas and that the protocol will be revised to include a methodology if this is desired at PINN. Current objectives related to riparian monitoring if any should be removed or clearly identified as a future objective which can't be addressed by the current protocol.

I included a whole section about how much riparian was surveyable under the current protocol. Apparently that is still considered "insufficient." Roads and trails pass through every vegetation type in the parks. You wanted riparian addressed specifically. I did. Riparian areas are not specifically included or excluded, but we're surveying a fair portion of them. I don't know what else to say about it. Methods for riparian are the same as for trails: a linear feature searched for invasives. At PINN several stream reaches double as trails, since they are dry and open a good portion of the year.

Here's one of the many trails through riparian areas in SFAN parks, at Point Reyes.

Here's an aerial of a part of Chalone Creek in Pinnacles. The creek not only looks like a trail, it doubles as the South Wilderness Trail for much of its length.

5. The guilds that are identified are problematic and also somewhat inconsistently used in different areas of the protocol. On pg. 18 guilds are listed as graminoid, herb, forb, shrub/subshrub, vine/groundcover, broom, thistle, and tree. These guilds are not defined anywhere and appear to be overlapping which may have confused the prioritization and

has potential to affect later analyses. How important is this to data analysis? Herbs would normally include graminoids, forbs, and many fern allies. Vines are not all groundcover and may have significant impacts when clinging to and overtopping native species. Brooms are also shrubs and thistles are forbs or in some cases sub-shrubs. Some are life forms but not all, e.g. thistle and broom. The inventory data sheet on pg. 24, Appendix C, SOP #3 uses trees, shrubs, forbs, ferns and allies, and grasses and allies instead of the above guilds.
Guilds are user-defined based on groupings of similar characteristics, such as cool-season grasses and warm-season grasses, and need not follow in lock-step with lifeform. Guilds were assigned to all species before prioritization, and these assignments can be found in the prioritization database Priors.mdb. No species was assigned to more than one guild, and guilds have not shifted. Brooms, vines/groundcovers, and thistles were broken out because of their importance as invasives, and similarity in spread and impact types. Forbs were split from herbs to denote non-annual species. Vines and groundcovers smother and usually spread clonally. Brooms may be shrubs, but they also fix nitrogen and have persistent seedbanks, and usually do not spread through frugivorous birds or wind as do most other shrubs on our lists. Thistles spread rapidly via wind and all our species have similar growth habits and impacts to similar areas. Certainly some guilds make more sense for analyses than others—jubata grass, red brome, and panic veldtgrass are quite different but all graminoids—and guild-based analyses may be adjusted accordingly (e.g., some guilds not used for analysis since they are too inlcusive/disparate). The inventory data sheet is merely a convenience for recording all species seen, and has no bearing on guild assignment or useage.

6. The text provides conflicting descriptions of areas surveyed adjacent to trails. For example, on pg. 18, a buffer of 4 feet was used to create an area around line elements such as roads and trails. Pg. 9 states that 20m was used. On pg. 13, inferences are confined to several meters from roads and trails. This is hardly enough distance to tell whether invasive species are spreading from roads and trails into sensitive or critical park habitat as asked in monitoring/management question 3 also on this page. Pg. 3 of SOP 2 says to walk out 10 meters to view plants, whereas the Weed Watcher instructions say to look 15 ft. on either side of the trail. This was confusing to me and should be clarified.
Page 18 describes the subwatershed prioritization process, not surveys; these areas were buffered to create a standard area to roughly measure the amount of infrastructure within a subwatershed and are not used as areas surveyed around roads or trails. Page 9 was an attempt to show that a sizeable amount of riparian habitat is visible from roads and trails; 20m is a mid-range detectability for our invasives and so it is used for our interpatch distance (among other reasons) as well as the riparian example. Inferences ABOUT NEGATIVE DATA are confined to a short distance (approximately five meters) from roads and trails for some species. Since I know of no occupancy or detectability calculations for plants (such as those discussed but never actualized from the 2005 I&M-USGS Austin Meeting), I must be conservative in my statements. Certainly if invasive plants are present, and unseen, they will only become more detectable over time (or die and be missed altogether) as long as survey seasonality is varied. So if they are present,

and spreading, they can be seen and measured, and it may be determined if that spread is toward or within sensitive habitat. Our surveys have yielded many detections dozens of meters from roads and trails, but I cannot reliably say whether all invasives at that distance are found. As for SOP 2, those are instructions for finding more plants once a patch has been found. They say to go out until the edge of the patch is just visible or 10m, <u>whichever is closer</u>, and search to be sure you have found all individuals before beginning mapping. Weed Watcher instructions say to look intensively in the 15-foot zone, but also to scan for plants further out. So, to sum up: most reliable data within 5m, includes negative data; other presence-based data limited only by sight distance and detectability (size and contrast).

7. The survey design, QA, and scheduling needs to be better explained. Volunteers may survey different lengths of trail or may not be consistent in their ability to survey the trails or may not be able to survey an area that hasn't been visited before (requiring an Advanced Surveyor who can do a floristic survey): how is all this coordinated? There is no explanation of how volunteers are assigned to roads and trails or sub-watersheds. The details of surveys are good , but an overview of the whole process in Section 3 is lacking. How is coverage over the entire list of roads, trails, and sub-watersheds assured?. Volunteers on their own will likely end up volunteering for popular areas and result in overlap, and park people with other jobs are likely to make incidental reports rather than gathering all the information and mapping data requested in this protocol. How are multiple surveys during different phenological periods arranged? This needs to be clearly summarized in the narrative. How do surveyors get started, how far do they go, if there is any overnight camping involved or if everything is a day trip, what they do if they don't finish a trail in a day, what happens when the trail crosses over into a different management unit, etc. It's also not clear how far off the trail the survey is conducted and how the information is used for species that are identified far afield, e.g. on surrounding hillsides or when surveyors use binoculars to identify occurrences.
   Different people have different abilities, hiking speeds, and plant spotting or identification skills. Volunteers may survey areas of their choice (e.g., near their home) or, if they do not express a preference, be assigned a set of trails. An area inventory does not need to be done before a volunteer can survey an area. Incidental reports are addressed in 3.1; a sentence was added for clarification. An incidental report this year with basic information—species and trail—led to several populations of a List 2 species being mapped by I&M staff following up; some plants were mis-identified, but most locations were correct. Further, park staff began immediate removal on receiving the reports from I&M. Not everyone can be an advanced observer, which is why the protocol is flexible and responsive to all levels of information. The technicians, under direction of the specialist, ensure all roads, trails, and subwatersheds set to be surveyed during a season actually are surveyed, and done during different times of the year. This was added to the table in what was Appendix D (now Appendix C).

8. The term "rate of cover" is used in several places. As cover cannot be a rate, this needs some restatement**.** (For example, see pgs. 3 and 6, SOP 2.)

I can't change the first, since it is a direct quote of an old document; but I deleted the second set since it was a table from that same document and we are no longer using that definition.

9. Guidance on inclusion rules for mapping an occurrence seems to be described in two different ways: 1) include an outlier patch in the main plant patch if the new patch covers an area that is less than 50% of the size of the main patch, or 2) Identify a new patch if it is greater than or equal to 20 m from another patch. (See Weed Watcher instructions and pg. 3 of SOP 2 for an example.)
   There is only one definition of a patch, a collection of individuals of the same species closer than 20m from each other. The Weed Watcher Manual was an old copy and has been replaced.

10. Pg. 23. Revising the species list annually. Annually shifting species from one list to another has potential to compromise the results of your surveys. Many invasive species have significant lag times while they adapt to new conditions. Reprioritization on an annual basis does not allow for this process. I would retain lists for 5-10 years before re-prioritizing them unless the results from other research indicate the prioritization is wrong.
    Generally, I would agree, and after the initial shifting we will update only after periodic reviews. However, in the first couple years of data collection we have found that species thought to be rare were quite widespread, making them a lower priority; or species were not present at all, making it inappropriate to train volunteers to survey for them (high likelihood of loss of search image) but staff and advanced observers do still search for them. So your fear that we will stop collecting data because a species is still rare and in its lag period is unfounded. Presence/absence data is still analyzable for Lists 1-3 and will not be compromised either.

General Organizational Issues:

Pagination: Pagination is incorrect or missing in several areas of the protocol. Pagination should be continuous; this applies to figures and tables as well. Some blank pages are numbered. For example, SOP#3, Appendix A (Weed Watcher instruction packet) is unnumbered, but if it was, Appendix B would start on page 22, not p. 20.

Organization is not clear. The SOPs appear entirely outside of the back cover of the protocol narrative. They must be either included with the narrative or in a separate volume that is also continuously paginated. They must appear in a numbered TOC somewhere.

Some sentences or small paragraphs appear to belong organizationally in other sections. For example:

Pg. 12, first sentence. I would move this to early in the introduction. *Did not do*
Pg. 17, sentence 3 starting with Primary to end of paragraph. This seems more appropriate for the preceding section, 2.4.1. *Done.*

Pg. 26, section 3.3, last sentence. Consider moving to section 3.5. *Done, sort of; put all data collection instructions under 3.3*

Appendix D of the Narrative is a mix of topics that might better be described as "Locations of priority subwatersheds and annual survey schedule." This would more logically include directions to the trailheads also provided in the appendix. It would be helpful to develop a table that connects trailheads with subwatershed units to facilitate locating this information. Since the information in this appendix is mixed, figures and tables should be numbered and have captions. *Done.*

SOP 2, pg. 2. First sentence in 2.1.2 is incomplete. *Done*

The appendix in SOP 2 seems like it should be a general appendix for inclusion in the narrative. *I think it's rather specific to the mapping, and will change more frequently, so I'd like to keep it where it is.*
SOP 3 is entitled Field Data Collection so it appears to be a more in-depth description of data collection methods. However, it includes a variety of topics such as equipment needed, and plant naming conventions, and primarily focuses on training. You might consider some reorganization of this material.
I think it's fine, and to split it would result in needless duplication.

Small details by page, paragraph, and line number:

vii: Figure 2 legend, italicize Latin name *Done*
xi: Under Appendix C, there should be a line for Priority 3 species (p 77) in the TOC *Removed Appendix C as it is redundant; this information is contained in the Weed Watcher data sheets in SOP 3.*
xix: Please remove reference to me; I act like a journal editor and it's not appropriate to acknowledge these contributions. Thanks anyway. *Done*
Pg. 9, par.1, l 12: buffering *Done*
Pg. 13, last paragraph. Substitute "first two" for "above" monitoring questions. *Did not do.*
Pg. 14, paragraph below #3: Substitute "to achieve the management goals" of this protocol for "for proper functioning" of this protocol. *Sort of did.*
Pg. 16, line 3. Delete first "based on topography" as redundant with rest of sentence. *Done*
Pg. 18. Reference to Table 2 in first paragraph is probably Table 3. Table 2 is on pg. 14. *Done*
Pg. 25. Substitute "survey" for "sampling". *Done, except the term "opportunistic sampling" is an accepted phrase and was not changed.*
Pg. 30. The database situation at GOGA seems needlessly complex. Is there some reason for it? *Yes, not everyone can access the same servers, necessitating three copies of the database. I wish it were easier, but until we have web-based entry (maybe in a decade or so)…*
Pg. 31, last sentence. Do you mean "habitat type" or "subwatershed"? *Habitat type.*
Pg. 34, section 5.3, paragraph 2. Delete double paren. *Done*
Pg. 35, Table 3. This annual work schedule is inconsistent with SOP 3, Appendix B where you show that survey work is conducted all year long. *Appendix B shows <u>detectability</u> of species, not*

when we search under this protocol. Others may survey year-round, and do, and the NR specialist may survey year-round, but primary season is as shown in Table 3..

Literature cited:
Adams et al. is 2005 (p 6) or 2006 (lit cit)? *Done*
Harris 2005 not cited in text? *Done*
NPS 2006 has 2 refs, one (p6) should be "b" and one (p 5) should be "a", and the order in the lit cit should be "a" then "b" *Done*
NRC 2002 not cited in text? *Section 1.2.1, "In 2002, the National Research Council…"*
PORE 1989 not cited in text, although the plan is mentioned on p 11. *Does it need to be more explicit? Isn't that a citation?*
PORE 2003 on p. 3 is not in lit cit *Corrected citation and added to list*
Scott and Wilcove 1998 not cited in text? *Done (this was replaced by Wilcove et al)*
The Nature Conservancy citations are not alphabetically correct. *I moved them as if "T" were the first letter, although that doesn't seem right to me since one generally doesn't count "little words" in alphabetizing.*
Thomas citation should come before Tilman. *Done*
Welch et al. 2007 not cited in text. Could be inserted on pg. 5 of the narrative. *Done (removed url and replaced with cite)*
Williams 2007 is cited as 2008 on page 8 *Done*

Pg. 73. Delete "kind of" and extra comma after French broom. Space needed between sentences after sentence ending in "spartina". Buffered misspelled. *Done*
Pg. 5, SOP 2. Citation should be in caption. *Done*

Most of these comments can be easily addressed. The organizational issues will likely be the most time-consuming. Please contact Kris Freeman, Technical Editor, at 206-685-4764 or by email at kfreeman@u.washington.edu if you need suggestions for or assistance with revisions. The technical details need to be addressed before you do this, however. As with the last review, please respond to each of the comments.

Sincerely,

James K Agee

James K. Agee
PWR Protocol Review Coordinator

Appendix SOP 1 D. Protocol review comments from July 2009 review, and how they were addressed.

Author's response to comments will appear in italicized font to distinguish from reviewer comments.

UNIVERSITY OF WASHINGTON

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July 23, 2009

The scientific review for the revised "Early Detection of Invasive Plant Species in the San Francisco Bay Area Network: A Volunteer-Based Approach" **is complete. The protocol receives the following decision:**

Acceptable*

The asterisk (*) above notes that the protocol is acceptable with the following inclusions incorporated into the draft. Dr. Latham and I reviewed the June 25, 2009 Responses to Reviewers Comments as well as the protocol itself. Most responses appear well justified, most minor errors were corrected, and clarifications made in the protocol were welcomed. The following issues need to be addressed:

1. There are minor "Error: bookmark not Defined" problems on pages iii and xi. There are some problems related to page numbering for pages with first order headings and the back cover won't print correctly with the current page numbering. Also, please note that newer templates have text related to level of peer review included on pg. ii that you might want to include for this protocol (optional). Minor misspellings occur on pg. xv (doesn't), pg. 94 (assessed), and pg. 185 (buffered).

   MK: Kris Freeman, PWR Technical Editor, has reviewed the document. Formatting errors and typos noted above have been corrected. Suggested text was inserted on page ii. In addition to the changes noted above, tables and figures in SOPs were renumbered and Appendixes in SOP included SOP number in the title.

2. Issue number 5 in the previous review dealt with inconsistent terminology for life forms/guilds. Although this was addressed in the response, it was not clarified in the protocol itself. There is no problem with using guilds, and those that are not consistent with life-forms, but they must be explained in the protocol. At present, there is one system for mapping shown on page 96 and another, simpler one, for data collection, on page 150. This could be rectified by brief explanations in both areas. On page 96, a

sentence could be added noting that this mapping system is more detailed than the data collection sheet on page 150, and on page 150, a sentence could be added noting that in mapping some species will be broken out into additional guilds shown on page 96.

The mapping symbology section on page 96 was clarified to show that the same guilds used in ranking are used for symbolizing species in mapmaking, and the inventory datasheet on page 150 was annotated with the following sentence:

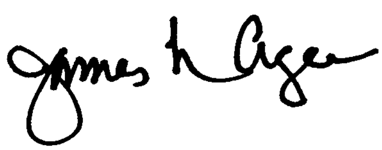
"Note that the lifeforms listed above for notational convenience do not correspond exactly with guilds used for ranking and map symbolization."

3. Issue number 8 in the previous review identified use of a nonsensical term ("rate of cover"). The response was that this came from another report and therefore could not be changed. Nevertheless it needs to be identified as a nonsensical phrase, not only "too subjective and difficult in the field". The reference occurs on pg. 94 and possibly in other places.

[sic] was inserted in the phrase "rate of cover" on page 91, and changed to "cover class" on page 94. The document was searched and no other uses of the offending phrase were found.

With an email commitment that these changes will be made, a Protocol Approval form will be submitted. When preparing the document for publication in the NRR series, you may wish to consult with our regional editor, Kris Freeman (kfreeman@u.washington.edu) for help with formatting.
Congratulations on a fine protocol.

Sincerely,



James K. Agee

Emeritus Professor of Forest Ecology
PWR Protocol Review Coordinator

Standard Operating Procedure (SOP) 2: Mapping. Version 1.2 (December 2008)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	5/1/07	Williams, A.	Adapted from 1999 GOGA Manual	Needed to conform with protocol, db	1.0
1.0	5/2/08	Jordan, J. and Williams, A.	Added to/changed general guidance; added introduction and appendix	Needed clarification, additional background, symbology	1.1
1.1	12/30/08	Jordan, J and Williams, A.	Added species to symbology table; changed sample map and added legend figure	Needed more up-to-date information	1.2
1.2	6/5/09	Jordan, J and Williams, A.	Added DSMapbook instructions	Needed more up-to-date information	1.3

Contents

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1.0 Introduction

Mapping is an essential part of invasive plant management. By providing a visual representation of the invaded landscape, maps can reveal patterns and priorities more clearly and quickly than any report. Like any information, maps are only as good as they are accurate and understandable. This SOP provides guidance for how to collect data, as well as how data should be displayed.

Mapping standards regarding *what* data we collect are covered in SOP 3 Field Data Collection, and generally follow North American Weed Management Area standards (Beard *et al.* 2001). Much of the mapping under this protocol will be point-based, or presence/absence for area searches. The guidance below, derived from the 1999 "GGNRA Manual for Surveying and Mapping Invasive Species," deals largely with the more difficult, and often subjective, *how* of population polygons ("patches") delineation. Patches will be recorded as *assessments* for List 1 and small populations of List 2 species.

2.0 Projections, Datums, and Spatial Coordinates

2.1 What Are They?

This section was "Stolen with pride" from the California Weed Mapping Handbook (Schoenig *et al.* 2002).

Mapping by nature involves the task of making a round world flat. Representing a three-dimensional object—the Earth—on a two-dimensional surface—paper or a computer screen—requires the use of a mathematical process called a "projection." While the spatial coordinates of latitude and longitude, measured in degrees of a circle, work well for pinpointing locations on a sphere, they do not translate well to a flat surface (the classic analogy is peeling an orange and trying to make the skin lay flat).

To make things more complicated, the planet is not actually an exact sphere, but an "oblate spheroid." (The diameter of the globe from pole to pole is smaller than the diameter across the equator.) Thus we model the three-dimensional surface of the earth as an "ellipsoid."

A "datum" is a base point for the ellipsoid that we use to model the earth's surface. The datum determines the placement of the coordinate system upon the ellipsoid, defining the origin and orientation of lines of latitude and longitude. There are two kinds of datum—a geocentric datum is centered on the earth's center of mass, and a local datum is slightly offset to a convenient location in order to accommodate a particular region of study. The North American Datum of 1927 (NAD27) is a local datum still used for many U.S. maps. The North American Datum of 1983 (NAD83) is a geocentric datum based on the most current measurements of the shape of the earth (WGS84 or GRS80). (This section is adapted from information found at <www.fgdl.org/tutorials/howto_reproject/MapProjectionBasics.html>.)

2.1.1 Universal Transverse Mercator (UTM)

UTM coordinates are in the form of "Northing" and "Easting", the number of meters north of the equator (in the northern hemisphere), and east of a meridian selected for a particular zone. Zones are 6 degrees east-west by 6 degrees northsouth. SFAN parks are in UTM Zone 10. Because UTM coordinates are in meters, they can be much easier to work with on the ground than degrees latitude and longitude, especially when distances are important.

2.1.2 Latitude and Longitude (Lat/Long)

This section was adapted from Wikipedia's "Geographic coordinate system" page.

Latitude (abbreviation: Lat. or (φ) pronounced phi) is the angle from a point on the earth's surface and the equatorial plane, measured from the centre of the sphere. Lines joining points of the same latitude are called parallels, and they trace concentric circles on the surface of the earth, parallel to the equator. The north pole 90° N; the south pole 90° S. The 0° parallel of latitude is designated the equator. The equator is the fundamental plane of all geographic coordinate systems. The equator divides the globe into the Northern and Southern Hemispheres.

Longitude (abbreviation: Long. or (λ) pronounced lambda) is the angle east or west of north–south line between the two geographical poles, that passes through an arbitrary point. Lines joining points of the same longitude are called meridians. All meridians are halves of great circles, and are not parallel. They converge at the north and south poles.

The line passing through the (former) Royal Observatory, Greenwich (near London in the UK) has been chosen as the international zero-longitude reference line, the Prime Meridian. Places to east are in the eastern hemisphere, and places to the west in the western hemisphere. The antipodal meridian of Greenwich is both 180°W and 180°E.

Degrees were divided in sixty parts, minutes and the minute into 60 seconds. This provided sufficient accuracy for navigation systems, but not for today's needs. A minute is designated by ′ or "m" and the second is designated by ″ or "s". Today, if greater accuracy is required, the second can be represented as a decimal number. Alternatively, angle can be expressed as a decimal number. The letters N,S, E,W can be used to indicate the hemisphere, or we can use "+" and "-" to show this. North and East are "+", and South and West are "-". Latitude and Longitude can be separated by a space or a comma.

Thus there are several formats for writing degrees, all of them appearing in the same Lat,Long order.

DMS Degree:Minute:Second (49°30'02"N, 123°30'30") or (49d30m02.5s,-123d30m30.17s)
DM Degree:Minute (49°30.0'-123°30.0'), (49d30.0m,-123°30.0')
DD Decimal Degree (49.5000°,-123.5000°), generally with 4 decimal numbers.

DMS is the most common format, and is standard on all charts and maps, as well as global positioning systems and geographic information systems.

2.1.3 Which Do We Use?

The National Park Service has no standard projection, datum, or coordinate system; generally, most parks use NAD83 and UTM for their datum and coordinate system. GeoWeed requires WGS84, but can accept UTM or Lat/Long in DD. This protocol uses WGS84 DD for data collection, which requires base layers to be reprojected in most cases. This protocol also assumes users know that ArcMap reprojects "on the fly;" ArcMap has reprojection tools; and ArcPad does not reproject layers.

3.0 General Mapping Guidance

The question of "What is a patch" has troubled many weed mappers. Since the purpose of early detection mapping is to give rapid responders an idea of where and approximately how much of a priority species has been found, our mapping may be more gross or more detailed than desired by others. The previous Golden Gate definition of "*a consistent rate* [sic] *of cover* and *a consistent distribution* over a particular area" proved too subjective and difficult in the field, so a standard interpatch distance of 20 meters was adopted. Adaptive sampling—walking out one detection distance from the edge of the patch and circling it, looking for more—has also been formally added.

- Map safely. Use the stylus to draw in points and polygons you can't—or shouldn't—reach.
- Map individual species, not specific areas. For each species, create a separate occurrence, even if more than one species occurs in the same area.
- Map discrete patches of a single species, unless they are closer than 20 meters apart. Separate data collection must be completed for each discrete patch.
- A patch may be an individual, a single cluster of individuals, or many clusters of individuals.
- When you see a particular species while surveying, walk out about 10m, or until you can just see the plants clearly (whichever is closer). Walk around the edge of the patch, looking for other individuals or clusters in the same logical, topographical area. If you see more, go out an additional distance from those and continue looking. Do not record an isolated individual or a single cluster until you have determined whether other individuals occur nearby or within a logical topographic area.
- Once you have surveyed the larger area, determine which cover class(es) and which distribution(s) most accurately describe what you see.
- Then fill out a GeoWeed data sheet, draw the patch on the map, and, if possible, GPS the patch.
- In addition to interpatch distance, use logical boundaries to delineate patches. Survey drainages, hilltops, meadows, or other logical topographical

The database offers seven choices for cover:

Trace	**<1%**
Low	**1-5%**
Moderate	**5-25%**
High	**25-50%**
Dense	**50-75%**
Very Dense	**75-95%**
Solid Stand	**95-100%**

The database offers six choices for distribution:

1. **Satellite**
2. **Scattered**
3. **Linear**
4. **Monoculture**
5. **Isolated**
6. **Uniform**
7. **Other**

features as a single unit.

- In general, use a 10x10 meter minimum mapping unit. The goal is to map all *occurrences* of each target species, but when determining boundaries between *occurrences* based on cover class, do not map a separate *occurrence* if one of the areas is less than 100 m^2. If only one patch occurs, map it no matter how small (unless dictated otherwise by priority level).

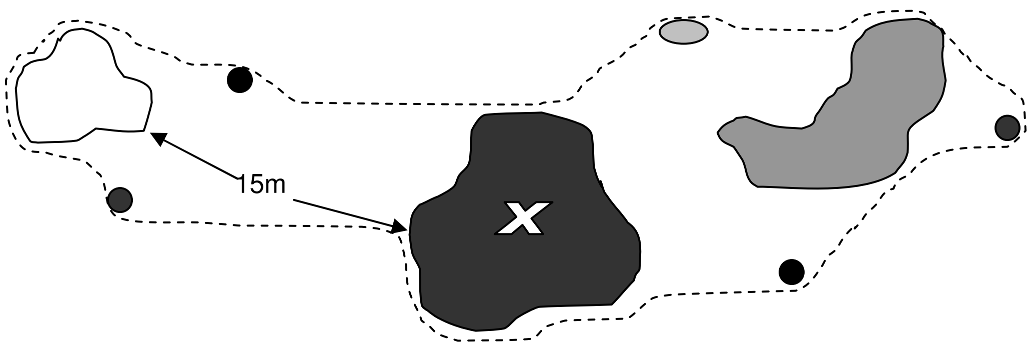

Figure 1.1. A theoretical mapping layout for a single species with multiple clumps of different cover classes, as shown by shading (darker color=higher cover).

The maximum interpatch distance for the example in Figure 2.1 is 15 meters, so the entire area is mapped as a single *occurrence* (X) and *assessment* (dashed line) with cover of 5-25%.While this appears to miss a level of detail, one of the reasons NAWMA uses infested acres instead of gross infested acres for reporting is to account for differences in how patches are delineated. If you were to draw each clump as its own assessment and cover class, you should come up with approximately the same number for infested acres (note that midpoints of cover classes are used to calculate infested from gross infested acres) as above:

Single assessment polygon	50m x 15m x 15% cover	**112.5m^2 infested**
Multiple polygons	(5m x 5m x 3% cover)	0.75m^2 infested
	+ 4(1m x 1m x 97.5% cover)	3.9m^2 infested
	+ (10m x 10m x 85% cover)	85.0m^2 infested
	+ (1m x 2m x 15% cover)	0.3m^2 infested
	+ (10m x 5m x 37.5% cover)	18.75m^2 infested
		108.7m^2 infested

Remember also that observers tend to overestimate cover over larger areas; you may want to adjust your estimates downward to compensate. See Figure 2.2 for cover class diagrams.

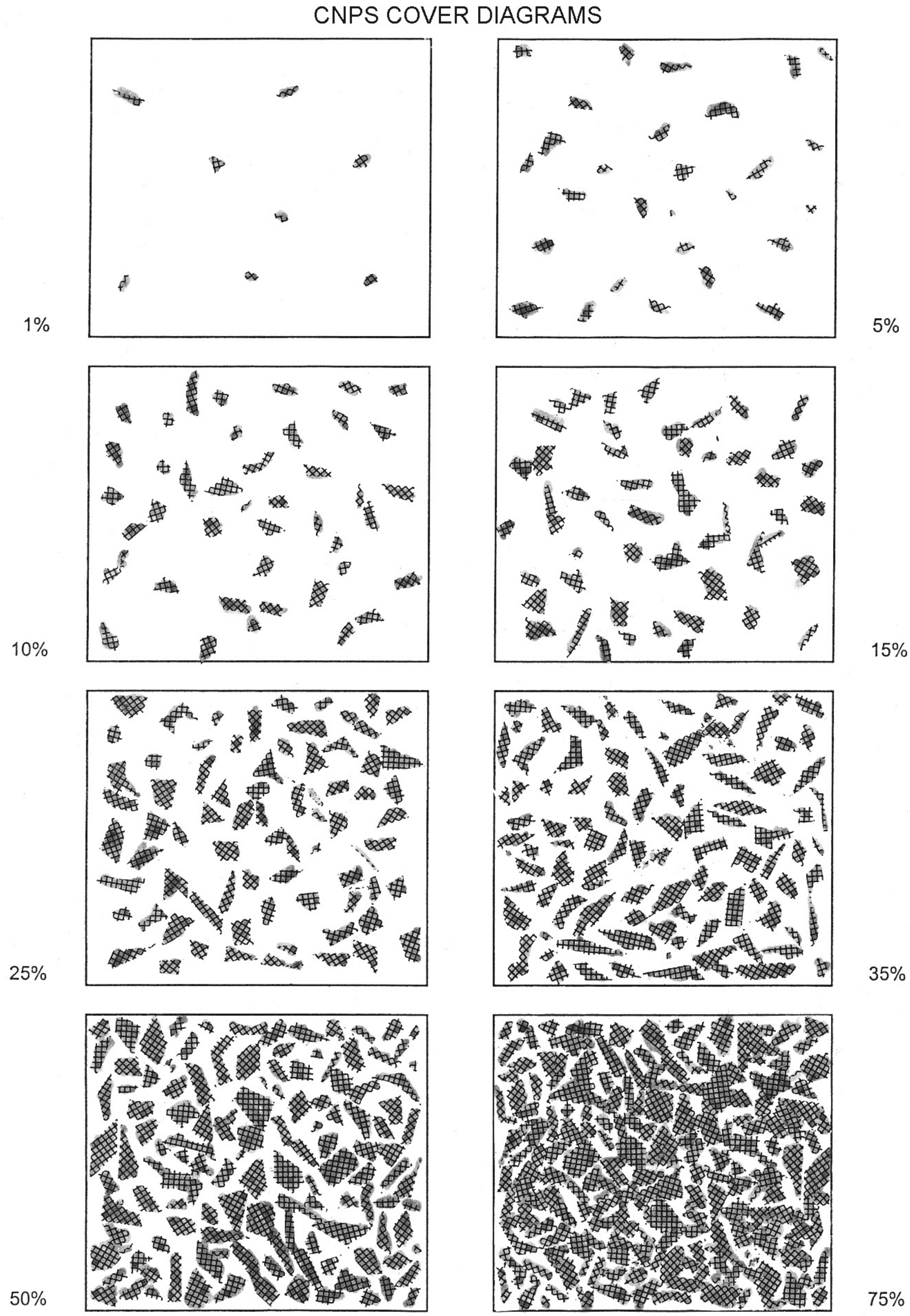

Figure 2.2. Cover class examples (CNPS 2002).

3.1 Remapping

The most recent data and maps should be taken out into the field during surveys. When finding an infestation of invasive plants, check to see if it has already been mapped. If it has, compare the current infestation to the recorded data: is the location, size, and cover class the same? Has it been assessed within the last five years? If the answer to either of these questions is no, then re-map it. Otherwise, note on the datasheet that it is still present.

3.2 Information Display

Information collected should be displayed on a map for use in revisits, annual map review, and communication/reporting. All maps should have a legend and title, scale bar, north arrow, grid lines or graticule marks, and creation date. A sample map can be seen in Figure 2.3; maps for the entirety on GOGA and PORE, current as of November 2008, are available on the Weed Watcher website: http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/maps.cfm. The legend for invasive species points is a separate page, due to the large number of species mapped (see appendix). Updated maps should be posted monthly in conjunction with reporting.

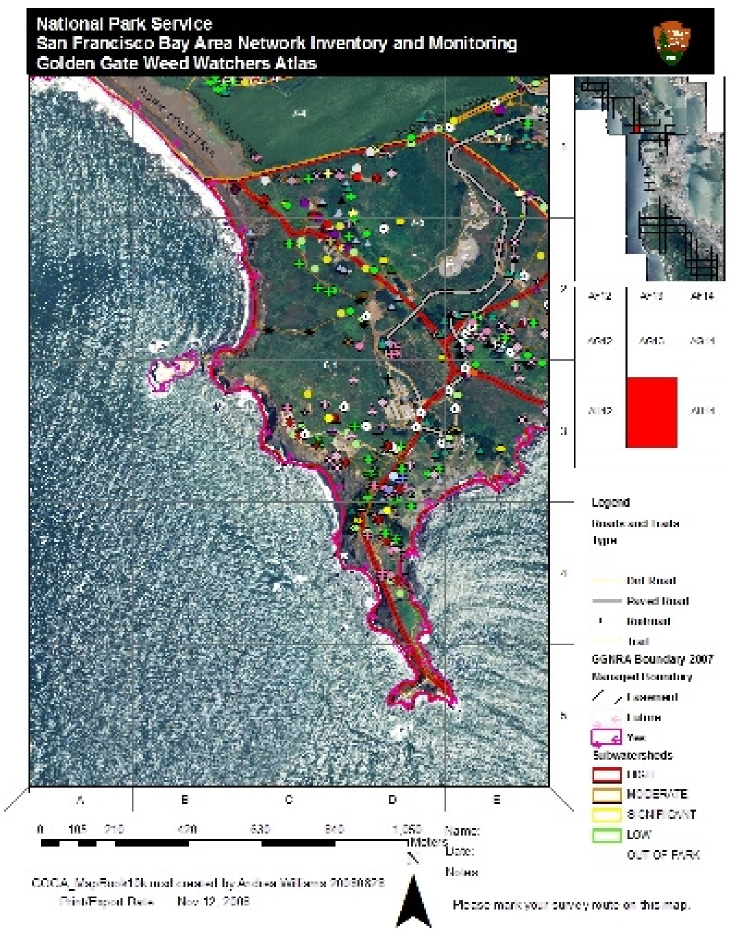

Figure 2.3. A sample early detection map.

3.1 Using DSMapbook

Primary mapmaking has already been done, as shown above, to make the Weed Atlas using ArcMap 9 and the DSMapbook script. Good general directions for using Mapbook are available with the script; make sure for new installations that the .pdf export bug is fixed, and that you check "embed fonts" in the export dialog of ArcMap and do a test export before batch export. To check if symbols have exported correctly, open the .pdf on a machine that does not have ESRI products installed; improperly exported symbols generally display as %, #, or letters.

3.1.1 Atlas Options

The Weed Atlases were created with a 1:10,000 grid, and pages where the boundary layer was not present were not made. The local and global locator frames are 1:100,000 and 1:1,000,000, and should show nine sheets and the entire park, respectively. These frames should show selected as red and be locked to their scales; these options are selectable through the properties dialog box.

3.1.2 SNOO Options

The What SNOO map grid is based off the survey tracks, so that each survey has its own map. Detailed directions for creating and managing survey tracklogs and creating the monthly maps based on surveys can be found in Appendix B. The scale for these maps varies based on the survey; symbology for newly found populations is the same as regular symbology but 18pt instead of 12pt to make the new points stand out on maps.

4.0 Literature Cited

Beard, R., C. Searle, D. Bruno, J. Rife, D. Cline, and B. Mullen. 2001. Weed mapping standards. North American Weed Management Association, Granby, Colorado. Online. (http://www.nawma.org). Accessed 31 August 2006.

CNPS. 2002. Cover diagrams from CNPS. California Native Plant Society, Sacramento, CA.

Schoenig, S., D. DiPietro, M. Kelly, D. Johnson, and R. Yacoub. 2002. California weed mapping handbook (draft). California Department of Food and Agriculture, Sacramento, California. Online. (http://www.cdfa.ca.gov/weedhome/pdfs/handbook_sept.pdf). Accessed 27 October 2007.

Wikipedia. 2008. Geographic coordinate systems. Online. (http://en.wikipedia.org/wiki/Geographic_coordinate_system). Accessed 6 May 2008.

Appendix SOP 2 A. Symbology for priority invasive plants.

Invasives were grouped into guilds for ranking; these same guilds are also used to guide representation on maps. The symbols are meant to be evocative of the species, so after a short time staff and volunteers should rarely need to refer to a legend to identify infestations already mapped. As time allows, a polygon symbology layer will be made using the point symbol as a marker line symbol inside a line of the same color as the point to outline the (unfilled) polygon.

Table 1. General guild symbology for invasive plants.

Guild	Point Shape
Trees	Triangles
Brooms	Diamonds
Shrubs	Pentagons
Thistles	Stars
Vines/groundcovers	Crosses
Forbs	Hexagons
Herbs	Circles
Graminoids	Asterisks

The table below shows shape and color for species that have been mapped; symbology may be imported from the layer file "Weedoccurrence.lyr" in [I&M]:\Shared\Vegetation\Invasive Plants\weedwatchers\EDsitemapes\GeoWeed_data. Additional symbols should be added by the Natural Resource Specialist as needed.

Table 2. GIS symbology for select priority invasive plants.

Scientific Name	Common Name	PLANTS Code	Guild Shape	Color (native=no change)
Acacia melanoxylon	blackwood acacia	ACME	Triangle 1	Native
Acacia decurrens	green wattle	ACDE	Triangle 2	No Radar Echo
Acacia longifolia	Sydney golden wattle	ACLO	Pentagon 2	Solar Yellow
Acacia redolens	bank catclaw	ACRE9	Pentagon 2	Citroen Yellow
Acacia verticillata	prickly moses	ACVE5	Pentagon 2	Autinite Yellow
Acroptilon[*Centaurea*] *repens*	Russian knapweed	ACRE3	Star 3	Rose Dust
Ageratina adenophora	thoroughwort, crofton weed	AGAD2	Pentagon 2	Arctic White
Ailanthus altissima	tree-of-heaven	AIAL	Triangle 2	Seville Orange
Allium triquetrum	threecorner leek	ALTR4	Hexagon 7	Native
Amaranthus albus	tumbleweed	AMAL	Star 6	Native
Ammophila arenaria	European beachgrass	AMAR4	Asterisk 2	Sage Dust
Anthoxanthum odoratum	sweet vernal grass	ANOD	Asterisk 2	Yucca Yellow
Arctotheca calendula	capeweed	ARCA45	Cross 4	Autinite Yellow
Arundo donax	giant reed	ARDO4	Asterisk 2	Tarragon Green

Table 2. GIS symbology for select priority invasive plants (continued).

Scientific Name	Common Name	PLANTS Code	Guild Shape	Color (native=no change)
Berberis darwinii	Darwin's barberry	BEDA	Pentagon 2	Electron Gold
Brassica nigra	black mustard	BRNI	Hexagon 2	Dark Umber
Brassica rapa	field mustard	BRRA	Hexagon 2	Burnt Umber
Briza maxima	big quakinggrass	BRMA	Asterisk 2	Raw Umber
Bromus madritensis	compact brome	BRMA3	Asterisk 2	Purple Heart
Bromus rubens	red brome	BRRU2	Asterisk 2	Tuscan Red
Bromus tectorum	cheatgrass	BRTE	Asterisk 2	Yogo Blue
Calendula arvensis	field marigold	CAAR	Circle 2	Electron Gold
Cakile maritima	European searocket	CAMA	Circle 2	Turquoise Dust
Carduus acanthoides	plumeless thistle	CAAC	Star 2	Native
Carduus pycnocephalus	Italian thistle	CAPY	Star 4	Fushia [sic] Pink
Carduus tenuiflorus	slender-flowered thistle	CATE2	Star 4	Ginger Pink
Carpobrotus chilensis	sea fig	CACH38	Cross 4	Amethyst
Carpobrotus edulis	hottentot fig, freeway iceplant	CAED3	Cross 4	Medium Fushia [sic]
Carthamus lanatus	woolly distaff thistle	CALA20	Star 3	Lime Dust
Centaurea calcitrapa	purple starthistle	CECA2	Star 3	Amethyst
Centaurea melitensis	Napa thistle, tocalote	CEME2	Star 4	Autinite Yellow
Centaurea solstitialis	yellow starthistle	CESO3	Star 3	Solar Yellow
Chenopodium ambrosioides	Mexican-tea	CHAM	Circle 2	Sage Dust
Chasmanthe floribunda	African cornflag	CHFL9	Hexagon 2	Fire Red
Cirsium arvense	Canada thistle	CIAR4	Star 3	Rhodolite Rose
Cirsium vulgare	bull thistle	CIVU	Star 3	Fushia [sic] pinkP
Conicosia pugioniformis	narrow-leaved iceplant	COPU18	Cross 4	Solar Yellow
Conium maculatum	poison hemlock	COMA2	Circle 3	Arctic White
Cortaderia jubata	purple pampas grass, jubata grass	COJU2	Asterisk 2	Rhodolite Rose
Cortaderia selloana	Uruguayan pampas grass	COSE4	Asterisk 2	Arctic White
Cotoneaster franchetii	orange cotoneaster	COFR3	Pentagon 2	Fire Red
Cotoneaster pannosus	silverleaf cotoneaster	COPA14	Pentagon 2	Poinsettia Red
Cotoneaster species	cotoneaster	COTON	Pentagon 2	Mars Red
Crataegus monogyna	oneseed hawthorn	COMO3	Pentagon 2	Tuscan Red
Cynodon dactylon	Bermudagrass	CYDA	Asterisk 2	Medium Key Lime
Cytisus scoparius	Scotch broom	CYSC4	Diamond 5	Solar Yellow
Cytisus striatus	Portuguese broom, striated broom	CYST7	Diamond 3	Native
Datura stramonium	jimsonweed, thorn apple	DAST	Circle 2	Macaw Green
Delairea odorata	cape ivy	DEOD	Cross 4	Native
Digitalis purpurea	purple foxglove	DIPU	Circle 2	Ginger Pink

Table 2. GIS symbology for select priority invasive plants (continued).

Scientific Name	Common Name	PLANTS Code	Guild Shape	Color (native=no change)
Dipsacus fullonum	common teasel, Fuller's teasel	DIFU2	Star 3	Arctic White
Dittrichia graveolens	stinkweed	DIGR4	Circle 2	Medium Yellow
Echium candicans	Pride of Madeira	ECCA5	Pentagon 2	Medium Azul
Egeria densa	Brazilian waterweed, elodea	EGDE	Cross 4	Malachite Green
Ehrharta calycina	perennial veldt grass	EHCA	Asterisk 2	Cordovan Brown
Ehrharta erecta	panic veldt grass	EHER	Asterisk 4	Native
Erechtites glomerata	Cutleaf burnweed	ERGL8	Circle 2	10% Gray
Erechtites minima	Coastal burnweed	ERMI6	Circle 2	Aster Purple
Eucalyptus globulus	bluegum eucalyptus	EUGL	Triangle 2	Blue Gray Dust
Euphorbia lathyris	gopher plant, caper spurge	EULA4	Hexagon 2	Turquoise Dust
Euphorbia oblongata	eggleaf or oblong spurge	EUOB4	Hexagon 2	Lemongrass
Foeniculum vulgare	sweet fennel	FOVU	Hexagon 2	Medium Key Lime
Genista monspessulana	French broom	GEMO2	Diamond 5	Macaw Green
Hedera canariensis	Algerian ivy	HEDCA	Cross 2	Native
Hedera helix	English ivy	HEHE	Cross 1	Native
Helichrysum petiolare	licorice plant	HEPE8	Pentagon 2	Sage Dust
Hirschfeldia incana	shortpod mustard	HIIN3	Hexagon 2	Citroen
Holcus lanatus	velvet grass	HOLA	Asterisk 2	Lilac Dust
Hypericum perforatum	Klamathweed	HYPE	Hexagon 3	Native
Ilex aquifolium	English holly	ILAQ80	Triangle 2	Poinsettia Red
Lactuca serriola	prickly lettuce	LASE	Star 3	Yucca Yellow
Lathyrus latifolium	perennial pea	LALA4	Cross 4	Peony pink
Lepidium latifolium	perennial pepperweed	LELA2	Hexagon 2	Indicolite Green
Leptospermum laevigata	Australian teatree	LELA29	Pentagon 2	Yucca Yellow
Leucanthemum maximum	Shasta daisy	LEMA8	Circle 19	Native
Leucanthemum vulgare	ox-eye daisy	LEVU	Circle 2	Arctic White
Linaria vulgaris	butter-and-eggs, common toadflax	LIVU2	Hexagon 3	Solar Yellow
Linum bienne	pale flax	LIBI5	Circle 2	Sodalite Blue
Lolium multiflorum	Italian/annual ryegrass	LOMU	Asterisk 2	Tzavorite Green
Lolium perenne	Italian/perennial ryegrass	LOPE	Asterisk 2	Tzavorite Green
Lolium temulentum	darnel	LOTE2	Asterisk 2	Fern Green
Malva parviflora	cheeseweed	MAPA5	Hexagon 2	Medium Lilac
Marrubium vulgare	horehound	MAVU	Hexagon 2	Sage Dust
Melilotus alba	white sweetclover	MEAL2	Circle 14	Arctic White
Mentha pulegium	pennyroyal	MEPU	Hexagon 2	Heliotrope

Table 2. GIS symbology for select priority invasive plants (continued).

Scientific Name	Common Name	PLANTS Code	Guild Shape	Color (native=no change)
Mentha spicata var. *spicata*	spearmint	MESP3	Hexagon 2	Light Apple
Mentha X *piperita*	peppermint	MEPI	Hexagon 6	Light Apple
Myoporum laetum	Ngaio tree	MYLA5	Triangle 6	Arctic White
Myosotis latifolia	broadleaf forget-me-not	MYLA4	Circle 2	Yogo Blue
Nicotiana glauca	tree tobacco	NIGL	Triangle 2	Fern Green
Oxalis pes-caprae	Bermuda buttercup	OXPE	Hexagon 2	Solar Yellow
Parapholis incurva	curved sicklegrass	PAIN	Asterisk 2	Gray 30%
Phalaris arundinacea	reed canarygrass	PHAR3	Asterisk 2	Lime Dust
Picris echioides	bristly oxtongue	PIEC	Star 4	Solar Yellow
Piptatherum miliaceum	Smilo grass	PIMI3	Asterisk 2	Sodalite Blue
Plantago lanceolata	English plantain	PLLA	Hexagon 2	Peacock Green
Poa bulbosa	bulbous bluegrass	POBU	Asterisk 2	Lapis Lazuli
Polygonum arenastrum	oval-leaf knotweed	POAR11	Hexagon 2	Leaf Green
Prunus avium	sweet cherry	PRAV	Triangle 2	Mars Red
Pyracantha angustifolia	narrowleaf firethorn	PYAN	Pentagon 2	Leaf Green
Raphanus sativus	wild radish	RASA2	Hexagon 2	Lepidolite lilac
Robinia pseudoacacia	black locust	ROPS	Triangle 2	Arctic White
Rosa canina	dog rose	ROCA3	Pentagon 2	Medium Fushia [sic]
Rosa eglanteria	sweetbriar rose	ROEG	Pentagon 2	Ginger pink
Rubus discolor [*procerus, armeniacus*]	Himalayan blackberry	RUDI2	Pentagon 2	Dark Amethyst
Rumex crispus	curly dock	RUCR	Hexagon 2	Cherry Cola
Rumex acetosella	common sheep sorrel	RUAC3	Hexagon 2	Poinsettia Red
Salsola tragus	prickly Russian thistle	SATR12	Star 3	Tuscan Red
Scabiosa atropurpurea	mourningbride	SCAT	Circle 2	Rhodolite Rose
Schinus molle	Peruvian peppertree	SCMO	Triangle 2	Gray 60%
Silybum marianum	blessed milkthistle	SIMA3	Star 4	Peony Pink
Solanum nigrum	black nightshade	SONI	Pertagon 1	Native
Sparaxis tricolor	wandflower	SPTR	Hexagon 2	Electron Gold
Spartium junceum	Spanish broom	SPJU2	Diamond 5	Fir Green
Taeniatherum caput-medusae	Medusahead	TACA8	Asterisk 1	Yucca Yellow
Tragopogon dubius	yellow salsify	TRDU	Star 3	Apple Dust
Tribulus terrestris	puncturevine	TRTE	Cross 4	Spruce Green
Trifolium hirtum	rose clover	TRHI4	Circle 2	Tuscan Red
Ulex europaea	gorse, furze	ULEU	Diamond 1	Native
Verbascum blattaria	moth mullein	VEBL	Circle 2	Macaw Green
Verbascum thapsus	woolly mullein	VETH	Circle 2	Apple Dust
Vinca major	periwinkle	VIMA	Cross 4	Medium Azul
Xanthium spinosum	cocklebur	XASP	Star 5	Light Olivenite

National Park Service
San Francisco Bay Area Network Inventory and Monitoring
Weed Watchers Symbology

Legend

Weed Occurrences

Species Name

- Acacia decurrens/ACDE
- Acacia longifolia/ACLO
- Acacia melanoxylon/ACME
- Acacia redolens/ACRE9
- Acacia verticillata/ACVE2
- Ageratina adenophora/AGAD2
- Allium triquetrum/ALTR4
- Ammophila arenaria/AMAR4
- Anthoxanthum odoratum/ANOD
- Arctotheca calendula/ARCA45
- Arundo donax/ARDO4
- Berberis darwinii/BEDAXX
- Brassica rapa/BRRA
- Briza maxima/BRMA
- Bromus diandrus/BRDI3
- Bromus hordeaceus/BRHO2
- Bromus madritensis/BRMA3
- Bromus rubens/BRRU2
- Bromus tectorum/BRTE
- Calendula arvensis/CAAR
- Carduus pycnocephalus/CAPY2
- Carpobrotus edulis/CAED3
- Centaurea calcitrapa/CECA2
- Centaurea melitensis/CEME2
- Chasmanthe floribunda/CHFL9
- Cirsium vulgare/CIVU
- Conicosia pugioniformis/COPU18
- Conium maculatum/COMA2
- Cortaderia jubata/COJU2
- Cortaderia selloana/COSE4
- Cotoneaster franchetii/COFR3
- Cotoneaster lacteus/COLA
- Cotoneaster pannosus/COPA14
- Cotoneaster species/COTON
- Crataegus monogyna/CRMO3
- Cupressus macrocarpa/CUMA2
- Cynodon dactylon/CYDA
- Cytisus scoparius/CYSC4
- Cytisus striatus/CYST7
- Delairea odorata/DEOD
- Digitalis purpurea/DIPU
- Dipsacus fullonum/DIFU2
- Echium candicans/ECCA5
- Ehrharta erecta/EHER
- Erechtites glomerata/ERGL8
- Erechtites minima/ERMI6
- Eucalyptus globulus/EUGL
- Euphorbia oblongata/EUOB4
- Festuca arundinacea/FEAR3
- Foeniculum vulgare/FOVU
- Fumaria parviflora/FUPA
- Genista monspessulana/GEMO2
- Hedera helix/HEHE
- Helichrysum petiolare/HEPE8
- Hirschfeldia incana/HIIN3
- Holcus lanatus/HOLA
- Ilex aquifolium/ILAQ80
- Lathyrus latifolius/LALA4
- Leptospermum laevigatum/LELA29
- Leucanthemum maximum/LEMA8
- Leucanthemum vulgare/LEVU
- Linum bienne/LIBI5
- Mentha pulegium/MEPU
- Myoporum laetum/MYLA5
- Myosotis latifolia/MYLA4
- Oxalis pes-caprae/OXPE
- Parapholis incurva/PAIN
- Pennisetum clandestinum/PECL2
- Phalaris aquatica/PHAQ
- Phalaris arundinacea/PHAR3
- Pinus radiata/PIRA2
- Prunus avium/PRAV
- Pyracantha angustifolia/PYAN
- Raphanus sativus/RASA2
- Rosa eglanteria/ROEG
- Rubus discolor/RUDI2
- Rumex acetosella/RUAC3
- Schinus molle/SCMO
- Silybum marianum/SIMA3
- Solanum nigrum/SONI
- Sparaxis tricolor hybrid/SPTR
- Ulex europaeus/ULEU
- Vinca major/VIMA
- ? unknown/unknown

Please refer to your Weed Watcher manual for priority levels and common names.

Print Date: Oct 16, 2008

Figure 1. Graphic symbology for invasive plants.

Appendix SOP 2 B. What SNOO mapmaking instructions.

Creating Survey Tracklogs

1. Create new folder for appropriate month in the folder corresponding to the year and park in the Inpgogamahe1.nps.doi.net\Divisions:\Individual Vital Signs\Invasive Plants\spatial_information\EDsitemaps\survey_tracklogs folder
2. Open WhatSNOO Mapbook in Inpgogamahe1.nps.doi.net\Divisions:\Individual Vital Signs\Invasive Plants\spatial_information\EDsitemaps\2009edmaps
3. Open ArcCatalog from this map
4. In left side of box, open folder created in Step 1
5. Go to File, New, Shapefile
    a. This will open Create New Shapefile box
    b. Fill out the following information:
        - Name: SURVEY…. (the name of the survey)
        - Feature Type: Polyline
        - Spatial Reference
            1. Click Edit button
            2. Click Select button
            3. Choose "Geographic Coordinate Systems:
            4. Choose "World"
            5. Choose "WGS1984.prj"
            6. Click OK
    c. New shapefile should appear in contents box on right
6. Double-click on the new shapefile just created
7. Go to Fields tab
    a. Leave existing fields alone
    b. Add three new field names and choose data type as follows:

Field Name	Data Type
Surv_Date	Date
Observer	Text
Surv_ID	Text

    c. Click OK
8. Now add this shapefile to the WhatSNOO mapbook using the "Add Data" button
9. Edit this file in ArcMap:
    a. Click on the Editor toolbar button and Start Editing
    b. Choose folder containing SURVEY shapefile
    c. In Editor toolbar chose Task: "Create New Feature"
    d. Make sure Target is the correct survey, if not then choose correct SURVEY file
    e. Using the Sketch Tool
        - Click along survey route in the data view until line is complete
        - When finished drawing survey, right click and choose "Finish Sketch"
    f. Update Attribute Table

        - Right click on the survey layer in the display box
        - Open Attribute Table
        - Fill in correct information for Surv_Date, Observer, and Surv_ID
        - Close Attribute Table
    g. Click Editor button
        - Save Edits
        - Stop Editing

Merge Surveys for each month

1. Open ArcToolbox
    a. Expand "Data Management Tools"
    b. Expand "General"
    c. Choose "Merge"
2. Merge box will open
    a. Input datasets
        - Select all surveys for the month
    b. Output datasets
        - Browse to the same folder the surveys are in
        - Name Month_Surveys, ex: "May_Surveys"
        - Once surveys are merged, remove individual survey layers from the map

Update Occurrences

1. Open GeoWeed
2. Export all species from all subwatersheds in GeoWeed into the All Species folder in the appropriate year and park folder in Inpgogamahe1.nps.doi.net\Divisions:\Individual Vital Signs\Invasive Plants\spatial_information\EDsitemaps\Exported from GEOWEED\2009\GOGA
3. This will automatically update the All Occurrences layer in the WhatSNOO map
4. Create a folder for the appropriate month in the WhatSNOO Shapefiles folder in the same place as in #2
5. Export all species from only the subwatersheds surveyed for that month into this newly created folder
6. Using the Add Data button in ArcMap, browse to this folder and add the occurrence shapefile to the map
7. Rename this file in the display box: Month_Occurrences
8. Edit this file in ArcMap to include only occurrences found in the correct month and year:
    a. Click on the Editor toolbar button and Start Editing
    b. Choose folder containing Month_Occurrence shapefile
    c. Update Attribute Table
        - Right click on the Month_Occurrence layer in the display box
        - Open Attribute Table
        - Delete all occurrences not recorded in the correct month and year
    d. Click Editor button
        - Save Edits

- Stop Editing

9. Update symbology for Month_Occurrence shapefile
   a. Double click on layer in display box
   b. Go to Symbology Tab
   c. Click Import button
   d. Use drop down menu to choose All Occurrences
   e. Click OK
   f. SNAME should be in the value field
   g. Click OK
10. Add labels
    a. Go to Labels tab
    b. Check the box in front of "Label features in this Layer"
    c. Method: "Label all features the same way"
    d. Label Field: Use drop down menu to choose "SNAME"
11. Click OK

Create WhatSNOO Mapbook

1. Buffer the Month_Surveys file
   a. Open ArcToolBox
   b. Expand "Analysis Tools"
   c. Expand "Proximity"
   d. Choose "Buffer"
2. Buffer box will open
   a. Input feature: Month_Surveys
   b. Output feature: will automatically create file in same folder and add it to the map
   c. Distance: Linear Units:
      - Type 15 in first box
      - Choose meters from drop down menu
3. Delete Old Mapbook Series if there is one
   a. Go to Mapbook tab
   b. Right click on existing series and choose Delete
4. Create New Mapbook Series
   a. Click on Creat MapBook button in Mapbook toolbar
5. Map Sheet Wizard Box will open
   a. Choose Index layer: Month_Surveys_Buffer
   b. This field specifies the page name: use drop down menu to choose "Surv_ID"
   c. Click next, then Next
   d. Change extent
      - Variable should be marked
      - Change margin to 10 percent
   e. Click Finish

Export Map Book Maps for each Survey

1. View individual map book page in layout view
2. Click File button
3. Choose Export Map
4. Browse to folder
5. Change name to corresponding Survey ID
6. Save as type: PDF
7. Be sure the Embed All Fonts option is checked
8. Click Save
9. Be patient while map exports!

Standard Operating Procedure (SOP) 3: Field Data Collection. Version 1.1 (January, 2009)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	5/20/07	Speith, E.	Changed WIMS to GeoWeed, Updated Weed Watcher instructions	Database name change, Database interface changes	1.01
1.01	1/30/2009	Williams, A.	Changed Appendix A to 2008 updated version, added detectability index and inventory sheet	Updated plants lists, forms and contact info; add information	1.1
1.1	6/15/2009	Williams, A. and J. Jordan	Updated Weed Watcher data sheets and manuals, info on road surveys	To reflect most current information	1.2

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Appendices

1.0 Introduction

Focusing on covering a maximum amount of ground and using people with multiple skill levels necessitates prioritizing the amount and type of data collected. Central to this protocol are the prioritizations performed to target searches and species. The differing degrees of data collection allow the surveyor to take the appropriate amount of data for the infestation: the highest detail for invasive plant species that are not yet widespread in the parks, and small populations of widespread but highly invasive species; point data for larger populations of widespread but highly invasive species, small populations of purportedly less invasive species, and presence, by subwatershed, for low-priority invasive species. Less-advanced surveyors will only be taking data on higher-priority species, and build their data-collection and species-identification abilities through supervised field and classroom trainings. All surveyors will take negative data for the target species appropriate to their skill level.

For the initial surveys, point *occurrences* and polygon *assessments* will be mapped for Priority 1 species (see protocol narrative Appendix B); point *occurrences* (for all patches) and polygon *assessments* (if patch size is less than 100 m^2) for Priority 2 species; presence/absence, or point *occurrences* (if patch size is less than 100 m^2) for Priority 3 species; presence/absence recorded for lower-priority species (according to observer level), along with the *survey area*. For subsequent surveys most *occurrences* should already exist. EVERY mapping session (day/team) will include a new *survey area* polygon or line. Assessments also include ancillary data on habitat, phenology and distribution. Species identifications for occurrences and surveys have an associated confidence level to flag potential misidentifications.

Pre-field preparation of the handheld device, post-field download, data entry and QA/QC procedures may be found in SOP 5, Data Management.

2.0 Observer Types

2.1 Basic and Volunteer Observers

As mentioned in the protocol narrative, observers may be passive (presence data only, opportunistic sampling), volunteer, or staff; well-trained in plant identification or not; comfortable with digital data collection or not. While staff observers are expected to know at least Priority 1 and 2 species, and be able to take data with the GPS/PDA combination, volunteers may need to build to these levels on the job. The "Weed Watcher" program detailed in Appendix SOP 3 A shows how the program is tiered; below is a training syllabus for the program.

1st-level observer (prerequisite participation in one guided hike and/or the Weed ID 1 class)

1) Train volunteers to identify Priority 1 target plants. Training will take place during a one-hour orientation conducted by a SFAN I&M employee at a designated priority subwatershed. Each volunteer will be exposed to search images and identifying features for each of these plants and will receive a set of "Plant-out-of-Place" ID reference cards. Identification skills will be practiced during a two-hour guided hike along trails in the

designated high-priority watershed.

2) Train volunteers to use maps to record locations of target plants. Volunteers will be exposed to a combination of USGS 7.5 minute quad maps, aerial photographs, and/or GIS map layers during a one-hour orientation at a field site. Skills will be tested during a two-hour guided hike. Volunteers will receive take-home paper maps for use during unsupervised "Weed Watcher" patrols.

3) Train volunteers to collect occurrence data using paper data sheets. Skills will be tested during a two-hour guided hike. Volunteers will be given multiple methods to report their findings via email, drop-off locations, and on-line report form (in development through Parks Conservancy or BAEDN). Volunteers will receive take-home data collection sheets for use during unsupervised "Weed Watcher" patrols.

2nd-level observer (prerequisite participation in 3 guided hikes and/or two guided hikes and one Weed ID 1 class)

1) Train volunteers to identify Priority 1 & 2 target plants. Training will take place during two outings with a SFAN I&M employee. Volunteers will receive individual training on plant identification. Skills will be tested during a guided hike or via an on-line "Weed ID" test.

2) Train volunteers to collect occurrence data with greater precision using paper data sheets and maps. Skills will be tested during two guided hikes with a SFAN I&M employee.

3) Train volunteers to make assessments of occurrences. Training will include determining cover class and distribution of patches.

4) For volunteers interested in using GPS units: train volunteers to collect occurrence and assessment data using handheld GPS units programmed with the GeoWeed interface. Training will take place during a series of guided hikes and a one-hour individual training and/or a Biological Data Collection Using GPS class. Skills will be tested during guided hikes.

3rd-level observer (prerequisite participation in a minimum of 5 guided hikes, one hour of GeoWeed training, and one hour of GPS training and/or participation in a GPS biological data collection class)

1) Train volunteers to identify the full list of high-priority target plants. Training will take place during a series of outings with a SFAN I&M employee, catered to the individual's needs. Volunteers will receive a plant book for completing this requirement. Skills will be tested during the guided hikes.

2) Train volunteers to collect occurrence and assessment data using handheld GPS units programmed with the GeoWeed interface. Training will take place during a series of guided hikes and a one-hour individual training and/or a Biological Data Collection Using GPS class. Skills will be tested during guided hikes.

The different levels also allow a manager to know, at a glance, what level of data was gathered: whether the search was for a limited or longer list; what the confidence should be based on observer level; what the quality check procedure should be.

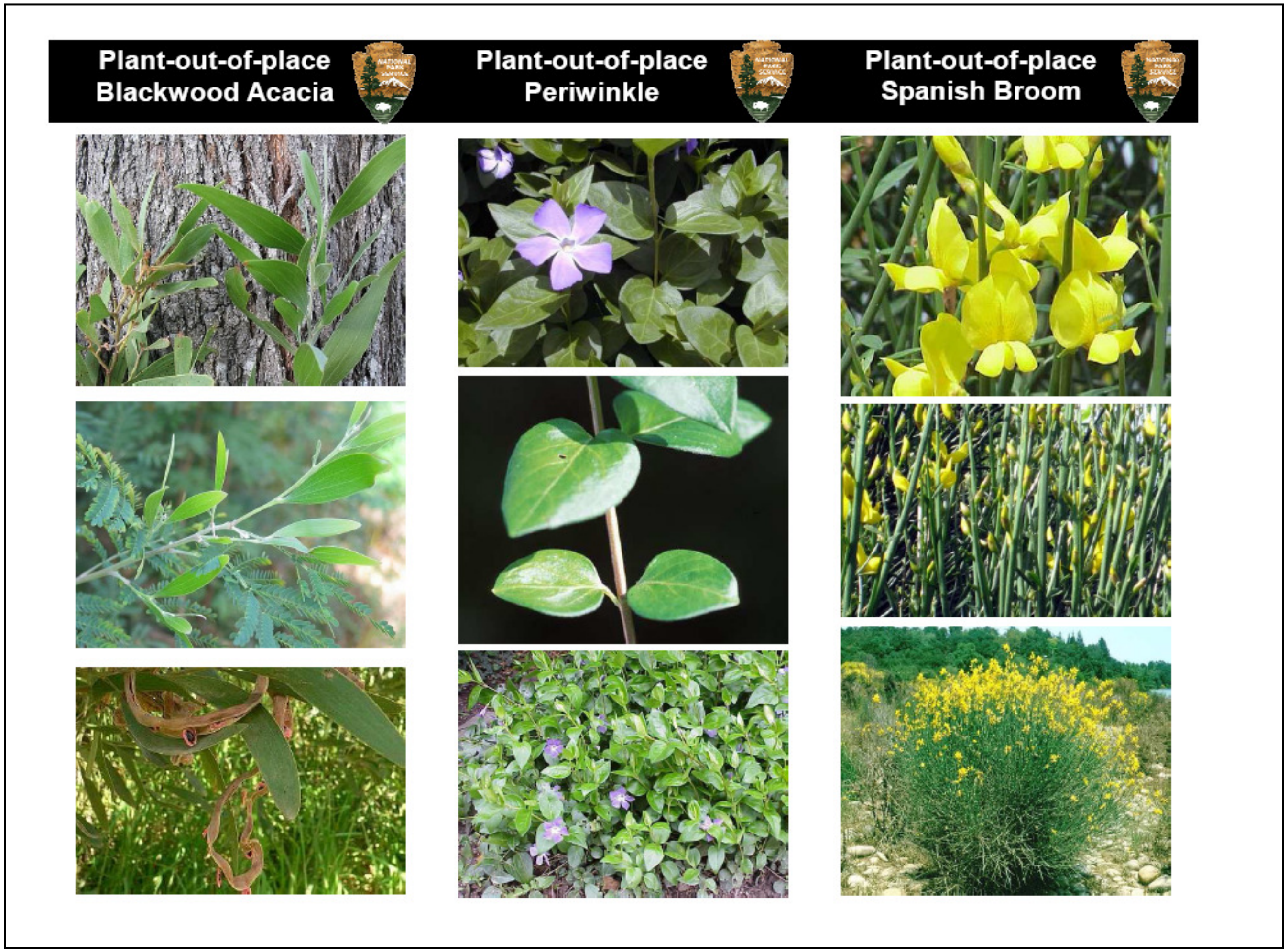


Figure 3.1. Sample front of “Weed Watcher” ID cards

EXOTIC SHRUB
Spanish Broom

(*Spartium junceum*)

Description

- Erect annual plant that grows 10-15 ft tall
- Golden yellow pea-like flowers 1 in long and clustered at the tips of the branches
- Braches have 5 green ridges
- Seed pods are 2—4 in long and dark brown

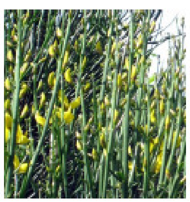
Habitat

- Grasslands, agricultural, riparian, and coastal areas
- Can grow in all but waterlogged soils

Don't confuse with…

French Broom which has:

- Sharply angled stems
- Smaller pods (1-2 in long)
- Also a plant-out-of-place



Spanish broom has needle-like branches

French broom has angled branches

Image credits: front page, bottom © John M. Randall/The Nature Conservancy; Back page, left- USGS Don Gardner, right- © Barry A. Rice/The Nature Conservancy

EXOTIC HERB
Periwinkle

(*Vinca major*)

Description

- Mat-forming perennial evergreen vine
- Purple flowers, March to July
- Leaves are oval, shiny, dark green, arranged opposite, 1-3 in long
- Stems contain a milky latex sap

Habitat

- Disturbed areas, roadside, garden waste dump sites, tree-covered drainages, and creeks
- Reproduces from small broken pieces of the stem

Don't confuse with…

Creeping St. John's-wort which has:

- Yellow flowers
- Clear sap
- Also a plant-out-of-place

Image credits: front, middle- James H. Miller, USDA Forest Service, www.forestryimages.org

EXOTIC TREE
Blackwood Acacia

(*Acacia melanoxylon*)

Description

- Fast growing tree that can reach 50 ft
- Feather-like leaflets which mature into sickle shaped dull-green leaves, 1/3 – 2/5 in long, >3 longitudinal veins
- Pale yellow pom-pom shaped flowers
- Twisted reddish-brown seed pods
- Flat roundish shiny black seeds encircled by pinkish-red stalk
- Rough grey bark

Habitat

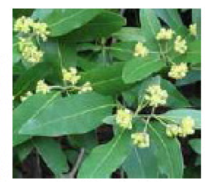
- Can grow in a wide range of habitats, especially disturbed sites
- Seeds can survive in the soil for 50 + years before sprouting

Don't confuse with…

California Bay Laurel which has:

- A pleasant spicy smell
- Showy flowers

Blackwood Acacia



California Bay Laurel

Image credits: front- Jackie Miles and Max Campbell; back Page, Left © 2001 Joe DiTomaso; Right © John Rawlings

Figure 3.2. Sample back of "Weed Watcher" ID cards.

2.2 Advanced Observers

An important component of managing invasive species is knowing where they do NOT occur. Every time an area has been systematically inventoried with a relatively high degree of confidence, it should be recorded. An advanced observer should be able to note all plant species seen within an area, at least to genus, and therefore have negative data for all other species. Such presence/absence data may not be appropriate for all purposes, as it tends to miss cryptic species, but invasive species are by definition not cryptic for long. Some work (Freilich and LaRue 1998) has shown that experience does not necessarily lead to being better at finding things; however, advanced observers should be able to recognize more species.

High-priority areas should be surveyed by an advanced observer, ideally in each of the potential flowering periods within a two- to three-year period. For SFAN, potential flowering periods are February-April, May-July, and August-October (see Appendix SOP 3 B for detectability calendar). Early surveys are also good for catching evergreen species which invade deciduous woodlands, such as ivy in riparian areas, and winter-flowering species such as brooms and acacias. If this is the first visit to a search area, the plant list must be compiled from field observations; future surveys can build off existing lists.

Staff should carry the following items with them in the field:

- GPS/PDA
- camera, preferably digital
- extra batteries and memory card for camera and GPS/PDA
- compass
- binoculars (7x35 or 8x30 preferred)
- large and small plastic bags
- notebook/datasheets and writing implements
- species list/checklist with PLANTS codes and priority levels
- paper map, of area and of survey site
- safety items: water, 1st aid, radio and spare battery or cell phone, food
- gloves
- flagging

Choosing binoculars
Binoculars are scored by two numbers: power and objective lens size.
High power brings object closer, and a large objective lens lends more detail to image—but is less important in good light conditions. A small field of view does not matter as much with stationary objects, but over 10x image will be shaky if hand-held. Binoculars rated 7x35 or 8x30 to 42 are recommended. Long eye relief is better for people with glasses or sunglasses.

Optional items:

- rangefinder (and optional hand-held road sign as reflective surface),
- 30 meter tape
- survey pins
- Jepson Manual or local flora
- CNPS cover diagram sheet (to help with % cover estimations; see SOP 2 Figure 3.2)

The search area should be saved as a shapefile, either from a tracklog or heads-up digitized from a paper map, with the ID cross-referenced to your survey results for that day. The naming convention is Survey-Subwatershed-Year-Month-Day-Firstname-Lastname: SURVEYSUWAYYYYMMDDFILA, so the 1/23/06 survey in Subwatershed 7-1 by Andrea Williams would be SURVEY070120060123ANWI. This is similar to invasives mapping naming convention, with substitution of SURVEY for GESPXX plant code. See Mapping SOP for how to map priority invasives found.

The GeoWeed interface can only record 20 species in the “Survey Area” tab while in the field, so a separate inventory sheet or file must be kept. Make a checklist of common species, segregated by trees, shrubs, forbs, graminoids, and ferns and fern allies, with space to write additional names or codes. Allow a column for confidence level in the identification, and reason codes for low confidence (see GeoWeed User’s Manual). Inventories from this sheet should be entered into GeoWeed on return to the office.

Advanced observers who are staff, or who are accompanied by staff, may use the following removal formula for immediate rapid response: if it would take longer to get back out than to remove it, then remove it. This must be tempered by the cumulative time spent on removal activities (*i.e.*, any one patch may not take long but many patches may add up to more than the total travel time), so observers should be familiar with the survey area or sure of the paucity of removal work before tackling a patch.

2.3 Road Surveys

Roadside surveys pose additional safety issues and challenges. For rapid surveys, or where shoulders or traffic volume do not permit walking safely, a minimum 2-person team should do a driving survey: one person drives and other(s) scan the roadside for target species. If target species are spotted, surveyors park in a safe turnout and walk back to the population. When walking along a roadside, surveyors must wear reflective vests appropriate to the type of road—*e.g.*, a Performance Class 2 or 3 vest if along a Federal-Aid Highway—and should walk along the shoulder facing oncoming traffic unless shoulder width or common sense dictates otherwise. Vests are in each office and I&M vehicle and additional information in Inpgogamahe1.nps.doi.net\Divisions:\Shared\Safety\General Safety Information\Roadside Work. For walking surveys, wear reflective gear and walk facing traffic; walking surveys are generally done along low-traffic routes. Driven survey miles should be reported separately from walked surveys.

2.4 Scientific Name and Code Conventions

In addition to the naming conventions for survey areas and occurrences, this protocol’s standards for scientific names and codes should help prevent misnaming due to synonymy issues. Nomenclature will conform to the most recent printed edition of *The Jepson Manual* (1993) to avoid the current rapid changes in taxonomic categorization; while these are easily trackable online and in NPSpecies (GeoWeed and NPSpecies both use the ITIS TSN as their key code), for example, having some records under *Festuca arundinacea*, others under *Lolium arundinaceum*, and others under the accepted *Schedonorus phoenix* would necessitate further steps in linking names or post-processing that can be avoided by only accepting the name printed in a standard, widely available and accepted reference book. Similarly, codes for these names are taken from the (nearly) universally available standard, documented, USDA PLANTS database (**http://plants.usda.gov**) rather than common convention of two- or three-letter genus-species codes, which can have multiple entries for a single combination. While local common conventions and the PLANTS database both solve the issue by adding a numeral, local codes are non-standard between locations and often not well documented. Therefore, codes dictated by a national entity and not made on-site have the advantage.

Plant codes

Scientific Name	GESP	GENSPE	PLANTS
Malus sylvestris	MASY	MALSYL	MASY2
Malva sylvestris	MASY	MALSYL	MASY

Even when only dealing with exotic species, three-letter codes can fail to be unique. Using local coding, which species becomes MASY1 and which MASY2 often depends on which is more locally common. Codes then lose transferability between parks and regions without extra crosswalking; but all parks and regions can use the PLANTS code, and have confidence in the code referring to the right plant.

3.0 Literature Cited

Freilich, J. E. and E. L. LaRue, Jr. 1998. Importance of observer experience in finding desert tortoises. Journal of Wildlife Management **62**(2): 590-596.

Regents of the University of California. 1993. *The Jepson Manual: Higher Plants of California* (third printing with corrections, 1996). James C. Hickman, editor. University of California Press. Berkeley, CA. xvii + 1400pp.

Appendix SOP 3 A. Weed Watcher instruction packet.

Weed Watchers- Invasive Species Early Detection Citizen Science Program

Golden Gate Weed Watchers
Invasive Plant Early Detection
Survey Manual

Introduction

Importance of Early Detection of Invasive Species

Aggressive non-native plants threaten to change the landscape of our national parks. These plants can permanently alter entire ecosystems, reducing the habitable area for the unique plants and animals of the San Francisco Bay Area in the very places set aside to protect them. The window of opportunity for detecting these plants before they become established is relatively small; by the time a plant is noticed as a problem it has usually spread throughout an area. The Weed Watchers help patrol the park for some of the newest invaders—and find them when they can still be prevented from becoming a permanent part of the landscape.

What can you do?

The Golden Gate National Recreational Area has found areas throughout the park that are considered at high risk for invasion. You can help patrol these areas for new weed invasions by conducting invasive species early detection surveys for some known pest plants. These surveys are part of a scientific monitoring program developed by the National Park Service Inventory and Monitoring San Francisco Area Network. The information gathered, both about the plants that are seen and the ones that aren't seen in an area, will be used to make management decisions and set habitat restoration priorities.

The instructions in this manual will explain how to participate as a Weed Watcher, including how to choose a site to safely conduct Weed Watcher surveys, what plants to look for, what information you need to record during your survey, and how to report your survey results.

Where to look?

The Golden Gate National Recreational Area stretches across 60 miles and seven ecological zones in Marin, San Francisco, and San Mateo counties. Since there is so much land to cover, the park has been divided into prioritized areas based on susceptibility to invasion and the need for special protection. Choose from the available maps of high priority areas included in the Map Appendix of this manual to find an area that you would like to get to know. You will be visiting this site every other month, at a minimum, so make it a place that will be easy for you to return to.

Map detail showing sub-watershed and trail names

Once you choose the area that you want to survey, visit the site and take a walk around. Fill out the ***site description*** area on the "Survey Form 1." Include directions to the site, the name of the trail/road that you are covering, and the sub-watershed name (a four-digit number such as 12-03 found on your survey map). You will fill out this site description each time you conduct a survey.

What plants to look for?

Twenty-two plants have been identified as the highest priority for the park to monitor and control. This ranking is based on both degree of invasiveness (status as a known ecosystem alterer) and feasibility of control (degree of existing infestation, cost of control methods). A list of these plants can be found on the "Golden Gate Weed Watcher List" included in this manual. These plants are divided into categories of priority. ID cards which include images, descriptive features, and look-alike plants are included for the List 1 species.

If you are unsure about the identity of a plant that you have found, try one of the following techniques.
- ***Take a picture*** of the plant in question. Include a leaf, a flower (if available), and something like a quarter or your hand for a size reference. Send your picture to Jenn_Jordan@nps.gov. Many cell phones have cameras and the ability to send images to an email address for the same price as a text message.
- ***Write a detailed description*** of the plant in question. Include as many details as possible, including details about the leaves (size, shape, alternate/opposite, lobed/entire); the flower (shape, color, size, orientation); size of plant; and habitat found in. Drawing a picture of the plant will help focus your attention on the details.

Weed Watcher Surveys
The Weed Watcher program is divided into two levels of observer participation. Level 1 surveys focus on locating the 11 highest priority, List 1 plants. The Level 2 survey covers 22 plants from both List 1 and 2 plants. The list of Priority 1 and 2 plants can be found later in this training manual.

When you begin conducting surveys, start with the Priority 1 species. This will allow you to get to know your survey area while focusing on a smaller number of plants. When you feel comfortable with your identification skills for the first 11 plants, you can test your ID skills by going on a guided hike with Weed Watchers program. This skills assessment is required if you would like to conduct the more detailed Level 2 survey.

Plant identification training and Level 2 certification are available from the Golden Gate National Recreation Area Weed Watchers program (contact Jenn_Jordan@nps.gov or call 415-331-5023).

Survey Method
After you have selected a survey location and have familiarized yourself with the plants to search for, you are ready to conduct a survey. Surveys are conducted along walking trails and roadways. You will intensively be looking for weeds on *5 meters* (15 feet) on either side of the survey route, and also scanning the hills and drainages on either side of the route. Try to stop every 100 meters (328 feet, or about the length of a football field) to scan your surroundings. Many discoveries occur when taking a break.

To reduce your impact on the area, please restrict your survey route to park trails. If you need to investigate a plant further from the trail, use binoculars to get a better look.

Survey Instructions: What is a plant occurrence?
When you encounter a plant that you identify as one of the targets, take a moment to look around and see if there are more plants around. You will be recording the number of patches, or *occurrences,* of each plant that you find, rather than the number of individual plants that you find. A plant patch consists of all plants of the same species within 20 m of the next closest plant. The number of plants in each patch will vary depending on the species that you come across. Once you find a plant, walk 20 m along the trail in each direction, and just visually survey off trail. Once you are able to go 20m without finding another plant in any direction, then you will be able to call the patch a single occurrence. This convention will help you save time while mapping.

For each plant that you encounter from Priority List 1 and 2 create an ***occurrence point*** at the center of the patch either with a GPS or on your paper map. At each ***occurrence point*** create a point on your paper survey map and record the information on the Weed Watcher Survey Form 1 or if you are using a GPS unit then record the information found under the Level 2 Survey Section on Weed Watcher Survey Form 2

Handheld GPS units are available for use during Weed Watcher survey outings. These GPS units have the mobile geographic information systems (GIS) and field mapping software, ESRI ArcPad, and the GeoWeed programs loaded onto them. These programs make it easy to record the location of the plants you find, and to digitally record your survey data. Contact the Weed Watchers program for more information about learning about GPS units and digital data collection.

Please follow these instructions for your Level 1 Weed Watcher survey!

Instructions for invasive plant surveys for all Priority 1 Weed Watcher plants, using Survey Form 1 and paper survey maps. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

Make sure that you have the necessary equipment with you.

- Survey Form 1
- Extra pencils or pens
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions
- Camera (*optional*)
- Binoculars
- GPS (*optional*)
- Field notebook and/or blank paper
- First Aid Kit (*optional*)
- Cell phone (for emergencies)

Survey Form 1:

Species name- Genus and species- find in the 1st two columns
 # Occurrences- keep tally marks for each separate occurrence
Location details- directions and distinguishing landmarks that will help others find the plant. Use cardinal directions (N,S,E,W) and distances to describe the directions, also include **Grid Location-** refer to the right and bottom of the paper map to determine (for example: D-4). **Other Info**- If it seems appropriate you can also include info about the size of the patch or the number of plants within the patch if they are easy to count.

Also mark all infestations found on paper map.

Negative Data for Level 1 Weed Watchers:
Negative data is important so that we know which plants are **NOT** found in certain locations. If you are confident that there are Priority 1 species that were not in your survey area, please note this by putting a 0 in the # of occurrences column on Survey Form 1 for each of these species.

At the end of your survey, mark your route on your map with a colored marker and fill out Survey Form 1. Include directions to the site and survey route in the ***trip report***, the total number of occurrences for each of the plants you did and didn't see, and location notes so we can find them on the map. Don't forget to fill out your name and contact information, and time spent on both Survey Forms

Return your data sheets to: (A self-addressed stamped envelope is available upon request.)
Weed Watchers
NPS Inventory & Monitoring San Francisco Area Network
Fort Cronkhite Bldg 1063
Sausalito, CA 94965
Email: Jenn_Jordan@nps.gov
Fax: (415) 331-5530
Phone: (415) 331-5023

Poison-oak-
"Leaves of three, let it be"

Safety First!

- **Poison-oak**, a plant know to cause severe dermal irritation, is found throughout the parks. Avoid contact!
- **Deer ticks**, which potentially can carry Lyme disease, are found throughout the park. Use a repellent containing 40% DEET to help deter ticks and always check yourself thoroughly during and after park excursions.
- **Stay on the trail!** This protects sensitive trailside habitats and you from hazardous terrain! Carry a **cell phone** if possible. In case of emergency call 911 or Park Dispatch (415-561-5505 or 415-561-5510

Please follow these instructions for your Level 2 (Basic) Weed Watcher survey!

Instructions for invasive plant surveys for all Priority 1 and Priority 2 Weed Watcher plants, using Survey Form 1 and Survey Form 2, and paper survey maps. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

1. Make sure that you have the necessary equipment with you.

- Survey Form 1
- Survey Form 2
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions
- Camera (*optional*)
- Binoculars
- GPS (*optional*)
- Field notebook and/or blank paper
- First Aid Kit (*optional*)
- Cell phone (for emergencies)
- Extra pencils or pens

2. For each Priority 1 and 2 plant encountered record an ***occurrence point*** on your paper map for the center of the patch. Label your point with the first 4 letters of your occurrence name (first 2 letters of the genus and first 2 letters of the species) and the unique occurrence #. Record the following information on Survey Form 2:

- Weed Occurrence Name: Consisting of the six-digit USDA plant code found on the plant list; the four-digit subwatershed code; the date in four-digit year, two-digit month, and two-digit day; and the occurrence number of that plant for that survey. For instance, if you found the third patch of *Carpobrotus edulis* on 14 July 2006 in Subwatershed 1-2 you would record CAED3X01022006071403 **(**USDAPC+SUWA+YYYYMMDD+U#).

- Species name (Genus species or common)

- Notes (location details such as cardinal direction and distance from path; comments on accessibility of plants; size of plants)

- Latitude and longitude (in decimal degrees, e.g. -122.12345, 37.12345)

3. For every Priority 1 plant, and Priority 2 plants whose patch size is smaller than 100 m^2 (10m by 10m; your arm span is likely between 1.5 and 2m long), you will also record some information about the density and distribution of the plants in the patch. To do this, create an ***assessment polygon***. An ***assessment polygon*** is an outline of the perimeter of the patch, created either on a paper map or with a GPS unit. Record the following information about the patch on Form 2:

Assessment

-Location notes- directions and distinguishing landmarks that will help others find the patch. Use cardinal directions (N,S,E,W) and distances to describe the directions.

-Cover Class- (0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%)over the entire infested area delineated by the assessment polygon.

-Size- the length and width of the patch, in meters or feet, based on pacing or a measuring tape.

-Phenology- record whether the plant is bolting (bolt), bud, dead/skeleton (dead), flowering (flow.), mature (mat.), rosette (rose.), seed set, seedling

- # of plants assessed (if possible, for jubata grass, trees, thistles, etc.)

- **Treated** (whether the patch was treated mechanically or chemically

4. At the end of your survey, mark your route on your map with a colored marker and fill out Survey Form 1. Include directions to the site and survey route in the ***trip report***, the total number of occurrences for each of the plants you did and didn't see, and location notes so we can find them on the map. Don't forget to fill out your name and contact information, and time spent on both Survey Forms 1 and 2.

5. Send us your survey! Don't forget to send us
- Survey map
- Survey Form 1
- Survey Form 2

Questions? Comments?

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Sausalito, CA 94965
Fax: (415) 331-5530
Phone: (415) 331-5023
Email: Jenn_Jordan@nps.gov

Please follow these instructions for your Level 2 (Advanced) Weed Watcher survey!

Instructions for invasive plant surveys for all Weed Watcher plants, using Survey Form 1 and Survey Form 2, paper survey maps, and a GPS unit loaded with GeoWeed. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

1. Make sure that you have the necessary equipment with you.

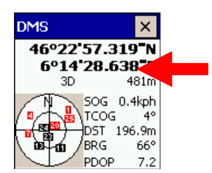
- Survey Form 1 - Survey Form 2
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions - Camera (*optional*)
- Binoculars - First Aid Kit (*optional*)
- Field notebook and/or blank paper - Extra pencils or pens
- Cell phone (for emergencies)
- GPS with background maps and GeoWeed area data (exported from desktop database)

2. Start the ArcPad program on your PDA (***Start> ArcPad 7.01***). Load the GeoWeed occurrence, assessment, survey, and treatment shapefiles (***Add Layers [ ]***. Click on to open My Computer, click on the + next to ***Documents and Settings,*** highlight ***GeoWeed*** and click **OK*,*** put a check in all 4 boxes √ for ***AreaSurveys, Weedassessments, Weedoccurrences, Weedtreatments***. Click on ***OK***. These layers will take a couple of minutes to load, so just wait without touching the pad. Then, load your background maps (***Add Layers [ ]> Documents and Settings> arcpadimagery> subwatershed#> OK***).

If PDA has an SD card, click on that + SD, then √ **arcpad_imagery** and click on the + of the specific watershed. When it asks if the layers should be in WGS84, click on YES.

3. For the Garmin IQue: Turn on the GPS by lifting up the antenna on the back of the unit by pulling down on the back sliding button and pressing the "GPS Position Window" button ( ).

For the Trimble Juno ST: Turn on the GPS by clicking the ( ) button. Then answer ***Yes*** when it asks "Would you like to activate it now?"



You will see a red circle with a yellow cross in the middle of the map when the unit is receiving GPS satellite reception.

You want the GPS points for latitude and longitude to always be in Decimal Degrees. From the GPS Position Window tap on the position coordinate display field until you get drop-down menu. Click on **WGS84 DD GPS**.

4. Enable the GeoWeed toolbar by pressing the GeoWeed key ( )

5. For each Priority 1 and 2 plant encountered record an ***occurrence point*** at the near center of the patch. First activate the GeoWeed occurrence layer ( ). The point may be taken using your current position by pressing the "Capture Point Using GPS" button ( ) or by using the stylus to draw a point on the map by pressing the "Point" button (**)** and then tapping the point on the map. Record the following information:

Basic Tab
- OCC Name: (USDAPC+SUWA+YYYYMMDD+U#)
- Species name (Genus species, drop-down list)
- Data Recorder

- Location notes (directions)
Regions Tab
- **Region 1** (subwatershed from drop-down list)
- Primary designation (check)
- Region 2 (secondary subwatershed or sitename from drop-down list)

Description tab
- Discovery Year (if known)
- Accuracy (GPS 1 is within 10 feet, GPS 2 is within 30 feet)
- **Confidence in Identification**/**Reason for doubt** (only enter if less than 95% confident in your ID)

6. For each Priority 1 plant patch, and for each Priority 2 plant with a patch < 100 m^2, record an ***assessment polygon*** around the perimeter of the patch. First activate the GeoWeed assessment layer ( ). Then create a polygon using satellite positions by pressing the "Polygon" button ( ) and then the "Add GPS Vertex" button ( ) and pause at each turn you make while walking around the boundary. Once you have finished collecting points, you must click the button in order to close the polygon and get to the data entry screen. Alternatively, you can use the stylus to draw a polygon on the map by pressing the "Freehand Polygon" ( ) and then using the stylus to draw a shape around the perimeter of the patch.

Record the following information:

Basic Tab
- Choose Occurrence (occurrence ID Code from the drop-down list)
- Data Recorder (data recorder name from the drop-down list)
- Notes (location directions)

Time
Time for assessment (mandatory) and treatment (if applicable)
- Start time (military time)
- End time (military time)

Size Tab
Note: Size is calculated from the polygon; ONLY enter data if you think that polygon may be incorrect—generally, for very small patches.
(Record accurate patch size, overrides polygon area, use for small patches)
Length x Width
Unit of Measurement
Direct Entry (of area in sq m, sq ft, sq mile, hectare)

Stats Tab
- GPS Accuracy (GPS 1 is within 10 feet, GPS 2 is within 30 feet)
- Area (Primary subwatershed location)
- Phenology (bolting, bud, dead/skeleton, flowering, mature, rosette, seed set, seedling)

Misc Tab
- Cover Class (0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%) for infested area
Also fill out the appropriate spaces on Survey Form 2.

Distribution
Cover Class Desc: Subjective measure of weed distribution
M = Monoculture, there is nothing but the weed there
U = Uniform distribution and size of weed patches

SA = Satellite, one main patch with smaller, satellite patches
SC = Scattered plants within the same patch
L = Linear distribution
I = Isolated patch

7. At the end of your survey, create a ***survey point*** for the site using the GeoWeed survey button ( ) and the "Capture Point Using GPS" button ( ). You will record the presence or absence of all Priority 1 species encountered on your survey. Record the following information:

Basic Tab
- **Area** (Primary subwatershed location)
- **Land use type** (Forest)
- **Dominant Veg. Type** (e.g. Coastal Scrub or Annual Graminoids or Forbs)

1-20 Tab
- **Note the absence of any of the following List 1 plants not encountered on your survey** (do not fill out phenology)

Arctotheca calendula
Centaurea calcitrapa
Cortaderia selloana
Cytisus scoparius
Cytisus striatus
Digitalis purpurea
Euphorbia oblongata
Helichrysum petiolare
Ilex aquifolium
Ulex europaea
Vinca major

Note: If you are able, record absence information for List 2 or other plants searched for but not seen on your survey, up to 20 plants (see Priority Species List)

8. At the end of your survey, mark your route on your map with a colored marker and finish filling out the presence/absence data on Survey Form 1 for the plants that you did and didn't see. Click on ▼ scroll down and click on **Exit**. Don't forget to completely fill out Survey Forms 1 and 2 including the trip report which describes your survey route, your contact information, and time spent on the survey. Do not record more than one survey before uploading the digital GeoWeed data, as this may lead to data loss.

Decision Tree for Priority 1, 2, and 3 plants

Priority 1 plants	Occurrence and Assessment
Priority 2 plants	Occurrence and Assessment if patch size is less than 100 m^2 Occurrence only if patch size is greater than 100 m^2
Priority 3 plants	Presence/Absence, or Occurrence if patch size is less than 100 m^2

Questions? Comments?
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Golden Gate Weed Watchers

Invasive Species Early Detection Survey

Survey Form 1 and Site Description

Going for a walk in the park? While you do keep your eye out for these park invaders. If you see a plant from this list, let us know by returning this form to the address at the bottom of the page. All it takes is one visit every other month to the trail of your choice to become a Golden Gate Weed Watcher. Instructions on the other side of this page. Happy Hunting!

Priority 1 Plant	Scientific Name	# Occurrences	Location details (grid #s) and/or plant description
Capeweed	*Arctotheca calendula*		
Purple Starthistle	*Centaurea calcitrapa*		
Uruguayan Pampas Grass	*Cortaderia selloana*		
Scotch Broom	*Cytisus scoparius*		
Portuguese Broom	*Cytisus striatus*		
Purple Foxglove	*Digitalis purpurea*		
Oblong Spurge	*Euphorbia oblongata*		
Licorice Plant	*Helichrysum petiolare*		
English Holly	*Ilex aquifolium*		
Gorse	*Ulex europaea*		
Periwinkle	*Vinca major*		

Priority 2 Plant	Scientific Name	# Occurrences	Location details (grid #s) and/or plant description
Blackwood Acacia	*Acacia melanoxylon*		
Thoroughwort	*Ageratina adenophora*		
Tocalote, Napa Starthistle	*Centaurea melitensis*		
Cape Ivy	*Delairea odorata*		
Common or Fuller's Teasel	*Dipsacus fullonum*		
Bluegum Eucalyptus	*Eucalyptus globulus*		
English Ivy	*Hedera helix*		
Oxeye daisy	*Leucanthemum vulgare*		
Pennyroyal	*Mentha pulegium*		
Oxalis pes-caprae	*Bermuda buttercup*		
Himalayan Blackberry	*Rubus discolor*		

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Www.weedwatcher.org

Golden Gate Weed Watchers
Invasive Species Early Detection Survey
Survey Form 1 Instructions

1. **Make sure that you have the necessary equipment with you.**
   - Weed Watcher Level 1 data and site description form
   - Survey map(s) of your area
   - Color marker
   - Binoculars
   - ID cards and/or field guides
   - First Aid Kit (*optional*)
   - Camera (*optional*)
   - Extra pencils or pens
   - GPS Unit (*optional*)
   - Cell phone (for emergencies)
   - Field notebook and/or blank paper

2. **Conduct your plant survey along roads and trails of the GGNRA.** Use the Golden Gate Weed Watcher survey maps and identification cards to help you find a high-priority survey area and to identify the plants on the other side of this form. Survey maps and ID cards are available for download at www.weedwatcher.org or by calling (415) 331-5023.

If you have looked at the cards and are still not sure that you found a priority plant, or you think that you have found something unusual, try one of the following:

- ***Take a picture*** of the plant in question. Include a leaf, a flower (if available), and something like a quarter or your hand for a size reference. Send your picture to Jenn_Jordan@nps.gov. *Hint*: many cell phones have cameras and the ability to send images to an email address.
- **Write a detailed description** of the plant in question. Include as many details as possible, including details about the leaves (size, shape, alternate/opposite, lobed/entire); the flower (shape, color, size, orientation); size of plant; and habitat found in. *Hint*: Drawing a picture of the plant will help focus your attention on the details.

3. **Fill out this data sheet** and send to the address on the front of this sheet. Let us know what you find!
   - *Trip Report*: **How do I describe where I completed my survey?** Many of the areas in the Golden Gate National Recreation Area have many official and unofficial names. Use the Weed Watcher surveys maps to show your approximate location and write the grid name and a description of the area you surveyed in the area provided. Have a GPS? Give us the latitude and longitude of your starting point, ending point, and pest plants encountered.

Want to learn more? Training is available to become a certified Weed Watcher. Contact us to find out about the next Weed Watcher training hike.

Name ______________________________ Phone ________________ Email ____________________

Other Observers _____________________ Survey Date ___________ Time (start- finish) __________

Trip Report (Survey Route, Site Description, Additional Plant Location Details):

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GeoWeed____(date)____(Int)

Golden Gate Weed Watchers Invasive Species Early Detection Survey Form Survey Form 2	SURVEY AREA ID: DATA RECORDER: OTHER OBSERVERS:		DATE: TIME START: TIME FINISH:
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% ______ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% ______ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
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ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% ______ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% ______ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	

Please return these survey forms to National Park Service SFAN Inventory and Monitoimg. Bldg 1063 Fort Cronkhite, Sausalito, CA 94965 Phone (415) 331-5023 Fax (415) 331-5530

Golden Gate Weed Watcher Priority Plant List June 2009

List	Scientific Name	Common Name	Priority	Family	SpCode
List 1 (Occurrence and Assessment)	*Arctotheca calendula*	capeweed	1	Asteraceae	ARCA45
	Centaurea calcitrapa	purple starthistle	1	Asteraceae	CECA2X
	Cortaderia selloana	Uruguayan pampas grass	1	Poaceae	COSE4X
	Cytisus scoparius	Scotch broom	1	Fabaceae	CYSC4X
	Cytisus striatus	Portugese broom, striated broom	1	Fabaceae	CYST7X
	Digitalis purpurea	purple foxglove	1	Scrophulariaceae	DIPUXX
	Euphorbia oblongata	eggleaf or oblong spurge	1	Euphorbiaceae	EUOB4X
	Helichrysum petiolare	licorice plant	1	Asteraceae	HEPE8X
	Ilex aquifolium	English holly	1	Aquifoliaceae	ILAQ80
	Ulex europaea	gorse, furze	1	Fabaceae	ULEUXX
	Vinca major	periwinkle	1	Apocynaceae	VIMAXX
List 2 (Occ and Assessment if patch <100m2)	*Acacia melanoxylon*	blackwood acacia	2	Fabaceae	ACMEXX
	Ageratina adenophora	thoroughwort, crofton weed	2	Asteraceae	AGAD2X
	Centaurea melitensis	Napa thistle, tocalote	2	Asteraceae	CEME2X
	Delairea odorata	cape ivy	2	Asteraceae	DEODXX
	Dipsacus fullonum	common teasel, Fuller's teasel	2	Dipsacaceae	DIFU2X
	Eucalyptus globulus	bluegum eucalyptus	2	Myrtaceae	EUGLXX
	Hedera helix	English ivy	2	Araliaceae	HEHEXX
	Leucanthemum vulgare	ox-eye daisy	2	Asteraceae	LEVUXX
	Mentha pulegium	pennyroyal	2	Lamiaceae	MEPUXX
	Oxalis pes-caprae	Bermuda buttercup	2	Oxalidaceae	OXPEXX
	Rubus discolor [*procerus, armeniacus*]	Himalayan blackberry	2	Rosaceae	RUDI2X
List 3 (Occurrence if [illegible])	*Brassica rapa*	field mustard	3	Brassicaceae	BRRAXX
	Briza maxima	big quakinggrass	3	Poaceae	BRMAXX
	Bromus diandrus	ripgut brome	3	Poaceae	BRDI3X
	Carpobrotus edulis	hottentot fig, freeway iceplant	3	Aizoaceae	CAED3X
	Conium maculatum	poison hemlock	2	Apiaceae	COMA2X
	Cortaderia jubata	Andean or purple pampas grass, jubata grass	3	Poaceae	COJU2X
	Cotoneaster franchetii	orange cotoneaster	3	Rosaceae	COFR3X
	Cotoneaster pannosus	silverleaf cotoneaster	3	Rosaceae	COPA14
	Ehrharta erecta	panic veldt grass	3	Poaceae	EHERXX
	Erechtites glomerata	Australian fireweed, cutleaf burnweed	3	Asteraceae	ERGL8X
	Erechtites minima	Australian fireweed, coastal burnweed	3	Asteraceae	ERMI6X
	Foeniculum vulgare	sweet fennel	3	Apiaceae	FOVUXX
	Genista monspessulana	French broom	3	Fabaceae	GEMO2X
	Holcus lanatus	velvet grass, Yorkshire fog	3	Poaceae	HOLAXX
	Phalaris aquatica	Harding grass	3	Poaceae	PHAQXX
	Pinus radiata	Monterey pine	3	Pinaceae	PIRA2X
	Rumex acetosella	sheep sorrel	3	Polygonaceae	RUAC3X
	Schinus molle	pepper tree	3	Anacardiaceae	SCMOXX
	Tamarix chinensis	saltcedar	3	Tamaricaceae	TACH2X
	Xanthium spinosum	spiny cocklebur	3	Asteraceae	XASP2X
	Xanthium strumarium	rough cocklebur	3	Asteraceae	XASTXX

Golden Gate Weed Watcher Priority Plant List June 2009

List	Scientific Name	Common Name	Priority	Family	SpCode
List 1 (Occurrence and Assessment)	*Ailanthus altissima*	tree-of-heaven	3.1	Simaroubaceae	AIALXX
	Albizia lophantha	silk tree; cape wattle	3.1	Fabaceae	ALLOXX
	Anthoxanthum odorata	sweet vernal grass	3.1	Poaceae	ANODXX
	Berberis darwinii	Darwin's berberis	3.1	Berberidaceae	BEDAXX
	Carduus acanthoides	plumeless thistle	3.1	Asteraceae	CAACXX
	Carthamus lanatus	woolly distaff thistle	3.1	Asteraceae	CALA20
	Centaurea solstitialis	yellow starthistle	3.1	Asteraceae	CESO3X
	Cirsium arvense	Canada thistle	3.1	Asteraceae	CIAR4X
	Crataegus monogyna	singleseed hawthorn	3.1	Rosaceae	CRMOXX
	Cynara cardunculus	artichoke thistle	3.1	Asteraceae	CYCAXX
	Cynodon dactylon	Bermudagrass	3.1	Poaceae	CYDAXX
	Dittrichia graveolens	stinkweed	3.1	Asteraceae	DIGR4X
	Echium plantagineum	salvation jane	3.1	Boraginaceae	ECPLXX
	Ehrharta calycina	perennial veldt grass	3.1	Poaceae	EHCAXX
	Hedera canariensis	Algerian ivy	3.1	Araliaceae	HECAXX
	Hypericum perforatum	Klamathweed	3.1	Clusiaceae	HYPEXX
	Nicotiana glauca	tree tobacco	3.1	Solanaceae	NIGLXX
	Phalaris arundinacea	reed canary grass	3.1	Poaceae	PHAR3X
	Pittosporum crassifolium	stiffleaf cheesewood	3.1	Pittosporaceae	PICRXX
	Pyracantha angustifolia	narrowleaf firethorn	3.1	Rosaceae	PYANXX
	Robinia pseudoacacia	black locust	3.1	Fabacae	ROPSXX
	Scabiosa atropurpurea	mourningbride	3.1	Dipsacaceae	SCATXX
	Spartium junceum	Spanish broom	3.1	Fabaceae	SPJU2X
List 2	*Bromus madritensis* ssp. *rubens*	red brome	3.2	Poaceae	BRMARX
	Bromus tectorum	cheat grass, downy brome	3.2	Poaceae	BRTEXX
	Dactylis glomerata	orchard grass, cocksfoot	3.2	Poaceae	DAGLXX
	Hirschfeldia incana	shortpod mustard	3.2	Brassicaceae	HIIN3X
	Festuca arundinacea	tall fescue	3.2	Poaceae	FEAR3X
	Leptospermum laevigatum	Australian teatree	3.2	Myrtaceae	LELA29
	Pennisetum clandestinum	Kikuyu grass	3.2	Poaceae	PECL2X
	Rosa eglanteria	sweetbriar rose	3.2	Rosaceae	ROEGXX
List 4 (Presence/absence only)	*Acacia baileyana*	cootamundra wattle	4	Fabaceae	ACBAXX
	Acacia dealbata	silver wattle	4	Fabaceae	ACDE3X
	Acacia decurrens	green wattle	4	Fabaceae	ACDEXX
	Acacia longifolia	Sydney golden wattle	4	Fabaceae	ACLOXX
	Acacia mearnsii	black wattle	4	Fabaceae	ACME80
	Acacia verticillata	prickly Moses	4	Fabaceae	ACVE2X
	Allium triquetrum	threecorner leek	4	Liliaceae	ALTR4X
	Alopecurus pratensis	meadow foxtail	4	Poaceae	ALPR3X
	Alopecurus pratensis	meadow foxtail	4	Poaceae	ALPR3X
	Amaryllis belladonna	belladonna lily	4	Liliaceae	AMBE3X
	Anredera cordifolia	Madeira vine	4	Basellaceae	ANCO6X
	Arrhenatherum elatius	tall oatgrass	4	Poaceae	AREL3X
	Barbarea verna	early yellowrocket	4	Brassicaceae	BAVEXX
	Barbarea vulgaris	winter cress	4	Brassicaceae	BAVUXX
	Bellardia trixago	bellardia	4	Scrophulariaceae	BETRXX
	Brachypodium distachyon	purple false brome	4	Poaceae	BRDI2X
	Brassica nigra	black mustard	4	Brassicaceae	BRNIXX
	Briza minor	little quakinggrass	4	Poaceae	BRMI2X
	Bromus catharticus	rescue grass	4	Poaceae	BRCA6X
	Bromus hordeaceus	soft brome	4	Poaceae	BRHO2X

Golden Gate Weed Watcher Priority Plant List June 2009

List 4 (Presence/absence only)

Scientific Name	Common Name	Priority	Family	SpCode
Bromus stamineus	roadside brome	4	Poaceae	BRST3X
Calendula arvensis	field marigold	4	Asteraceae	CAARXX
Carduus tenuiflorus	slender-flowered thistle	4	Asteraceae	CATU2X
Centaurea diluta	North African knapweed	4	Asteraceae	CEDI4X
Centranthus ruber	red valerian	4	Valerianaceae	CERU2X
Cestrum aurantiacum	orange jessamine	4	Solanaceae	CEAU2X
Chrysanthemum segetum	corndaisy	4	Asteraceae	CHSEXX
Coprosma repens	creeping mirrorplant	4	Rubiaceae	CORE4X
Cotula australis	Australian waterbuttons	4	Asteraceae	COAU3X
Cotula coronopifolia	brassbuttons	4	Asteraceae	COCO7X
Crocosmia X crocosmiiflora	crocosmia, montbretia	4	Iridaceae	CRCR6X
Cupressus macrocarpa	Monterey cypress	4	Cupressaceae	CUMA2X
Cytisus multiflorus	white spanishbroom	4	Fabaceae	CYMU3X
Daucus carota	Queen Anne's lace, wild carrot	4	Apiaceae	DACA6X
Digitaria sanguinalis	crabgrass	4	Poaceae	DISAXX
Dipsacus sativus	Indian teasel	4	Dipsacaceae	DISA9X
Duchesnea indica	mock-strawberry	4	Rosaceae	DUINXX
Echium candicans	pride of Madeira	4	Boraginaceae	ECCA5X
Epipactis helleborine	broadleaf helleborine	4	Orchidacaea	EPHEXX
Erigeron karvinskianus	Latin American fleabane	4	Asteraceae	ERKA2X
Escallonia rubra	redclaws	4	Grossulariaceae	ESRU4X
Euphorbia peplus	petty spurge	4	Euphorbiaceae	EUPE6X
Geranium retrorsum	New Zealand geranium	4	Geraniaceae	GEREXX
Gunnera tinctoria	Chilean gunnera	4	Gunneraceae	GUTIXX
Hainardia cylindrica	barbgrass	4	Poaceae	HACYXX
Hedypnois cretica	Cretanweed	4	Asteraceae	HECR2X
Hypericum calycinum	Aaron's beard	4	Clusiaceae	HYCA10
Ipomoea mutabilis	oceanblue morning-glory	4	Convolvulaceae	IPMU6X
Kniphofia uvaria	redhot poker	4	Liliaceae	KNUV80
Lathyrus latifolius	everlasting pea, perennial pea	4	Fabaceae	LALA4X
Lepidium strictum	upright pepperweed	4	Brassicaceae	LEST2X
Leucanthemum maximum	Shasta daisy and hybrids	4	Asteraceae	LEMA8X
Ligustrum ovalifolium	california privet	4	Oleaceae	LIOVXX
Linaria vulgaris	butter and eggs	4	Scrophulariaceae	LIVU2X
Lobularia maritima	sweet alyssum	4	Brassicaceae	LOMAXX
Lonicera japonica	Japanese honeysuckle	4	Caprifoliaceae	LOJAXX
Marrubium vulgare	horehound	4	Lamiaceae	MAVUXX
Mentha spicata var. spicata	spearmint	4	Lamiaceae	MESP3X
Mentha X piperita	peppermint	4	Lamiaceae	MEPIXX
Muehlenbeckia complexa	maidenhair vine	4	Polygonaceae	MUCO3X
Myosotis discolor	yellow and blue forget-me-not	4	Boraginaceae	MYDIXX
Myosotis latifolia	broadleaf forget-me-not	4	Boraginaceae	MYLA4X
Narcissus pseudonarcissus	common daffodil	4	Liliaceae	NAPSXX
Nerium oleander	oleander	4	Apocynaceae	NEOLXX
Parapholis incurva	curved sicklegrass	4	Poaceae	PAINXX
Parentucellia viscosa	yellow glandweed	4	Scrophulariaceae	PAVI3X
Paspalum dilatatum	dallis grass	4	Poaceae	PADI3X
Phalaris canariensis	annual canarygrass	4	Poaceae	PHCA5X
Phalaris minor	littleseed canarygrass	4	Poaceae	PHMI3X
Phalaris paradoxa	hood canarygrass	4	Poaceae	PHPA5X

Golden Gate Weed Watcher Priority Plant List June 2009

	Scientific Name	Common Name	Priority	Family	SpCode
List 4 (Presence/absence only)	*Pittosporum undulatum*	Victorian box	4	Pittosporaceae	PIUN2X
	Polycarpon tetraphyllum	fourleaf manyseed	4	Caryophyllaceae	POTEXX
	Prunus avium	bird cherry	4	Rosaceae	PRAVXX
	Prunus cerasifera	cherry plum	4	Rosaceae	PRCE2X
	Ranunculus muricatus	spinyfruit buttercup	4	Ranunculaceae	RAMU2X
	Ranunculus repens	creeping buttercup	4	Ranunculaceae	RARE3X
	Raphanus sativus	wild radish	4	Brassicaceae	RASA2X
	Schinus molle	pepper tree	4	Anacardiaceae	SCMOXX
	Senecio elegans	redpurple ragwort	4	Asteraceae	SEELXX
	Sinapis arvensis	charlock	4	Brassicaceae	SIAR4X
	Solanum marginatum	white-margined nightshade	4	Solanaceae	SOMAXX
	Sparaxis tricolor hybrid	Harlequin flower	4	Iridaceae	SPTRXX
	Tanacetum parthenium	feverfew	4	Asteraceae	TAPA6X
	Tetragonia tetragonioides	New Zealand-spinach	4	Aizoaceae	TETE3X
	Thinopyrum junceiforme	Russian wheatgrass	4	Poaceae	THJU3X
	Tragopogon porrifolius	purple salsify	4	Asteraceae	TRPOXX
	Tropaeolum majus	nasturtium	4	Tropaeolaceae	TRMA7X
	Verbascum blattaria	moth mullein	4	Scrophulariaceae	VEBLXX
	Watsonia borbonica	bugle-lily	4	Iridaceae	WABOXX
	Watsonia marginata	fragrant bugle-lily	4	Iridaceae	WAMA2X
	Watsonia meriana	bulbil bugle-lily	4	Iridaceae	WAMEXX
	Zantedeschia aethiopica	calla lily	4	Araceae	ZAAEXX
List 5 (Dune and Aquatic Plants)	*Ammophila arenaria*	European beachgrass	5	Poaceae	AMAR4X
	Ammophila breviligulata	American beachgrass	5	Poaceae	AMBRXX
	Aptenia cordifolia	heartleaf iceplant	5	Aizoaceae	APCOXX
	Arundo donax	giant reed	5	Poaceae	ARDO4X
	Carpobrotus chilensis	sea fig	5	Aizoaceae	CACH38
	Conicosia pugioniformis	narrow-leaved iceplant	5	Aizoaceae	COPU18
	Drosanthemum floribundum	showy dewflower	5	Aizoaceae	DRFL2X
	Eichhornia crassipes	water hyacinth	5	Pontederiaceae	EICRXX
	Mesembryanthemum crystallinum	ice plant	5	Aizoaceae	MECR3X
	Myriophyllum aquaticum	parrot's-feather	5	Haloragaceae	MYAQ2X
	Myriophyllum spicatum	Eurasian watermilfoil	5	Haloragaceae	MYSP2X
	Spartina alterniflora	Atlantic or smooth cordgrass	5	Poaceae	SPALXX

Point Reyes National Seashore Invasive Plant Early Detection Survey Manual

Introduction

Importance of Early Detection of Invasive Species

Aggressive non-native plants threaten to change the landscape of our national parks. These plants can permanently alter entire ecosystems, reducing the habitable area for the unique plants and animals of the San Francisco Bay Area in the very places set aside to protect them. The window of opportunity for detecting these plants before they become established is relatively small; by the time a plant is noticed as a problem it has usually spread throughout an area. The Weed Watchers help patrol the park for some of the newest invaders—and find them when they can still be prevented from becoming a permanent part of the landscape.

What can you do?

Point Reyes National Seashore has found areas throughout the park that are considered at high risk for invasion. You can help patrol these areas for new weed invasions by conducting invasive species early detection surveys for some known pest plants. These surveys are part of a scientific monitoring program developed by the National Park Service Inventory and Monitoring San Francisco Area Network. The information gathered both about the plants that are seen and the ones that aren't seen in an area will be used to make management decisions and set habitat restoration priorities.

The instructions in this manual will explain how to participate as a Weed Watcher, including how to choose a site to safely conduct Weed Watcher surveys, what plants to look for, what information you need to record during your survey, and how to report your survey results.

Where to look?

Point Reyes National Seashore includes 70,000 acres located within Marin County. Since there is so much land to cover, the park has been divided into prioritized areas based on susceptibility to invasion and the need for special protection. Choose from the available maps of high priority areas included in the Map Appendix of this manual to find an area that you would like to get to know. You will be visiting this site every other month, at a minimum, so make it a place that will be easy for you to return to.

Once you choose the area that you want to survey, visit the site and take a walk around. Fill out the ***site description*** area on the "Survey Form 1." Include directions to the site, the name of the trail/road that you are covering, and the sub-watershed name (a four-digit number such as 12-03 found on your survey map). You will fill out this site description each time you conduct a survey.

Map detail showing sub-watershed and trail names

What plants to look for?

Thirty plants have been identified as the highest priority for the park to monitor and control. This ranking is based on both degree of invasiveness (status as a known ecosystem alterer) and feasibility of control (degree of existing infestation, cost of control methods). A list of these plants can be found on the "Point Reyes Weed Watcher Weeds List" included in this manual.
These plants are divided into List 1 and List 2 categories of priority. ID cards which include images,

descriptive features, and look-alike plants are included for the List 1 species.

If you are unsure about the identity of a plant that you have found, try one of the following techniques.
- ***Take a picture*** of the plant in question. Include a leaf, a flower (if available), and something like a quarter or your hand for a size reference. Send your picture to Jenn_Jordan@nps.gov. Many cell phones have cameras and the ability to send images to an email address for the same price as a text message.
- ***Write a detailed description*** of the plant in question. Include as many details as possible, including details about the leaves (size, shape, alternate/opposite, lobed/entire); the flower (shape, color, size, orientation); size of plant; and habitat found in. Drawing a picture of the plant will help focus your attention on the details.

Weed Watcher Surveys
The Weed Watcher program is divided into two levels of observer participation. Level 1 surveys focus on locating the 11 highest-priority, List 1 plants. The Level 2 survey covers 30 plants from both List 1 and 2 plants. The list of Priority 1 and 2 plants can be found later in this training manual.

When you begin conducting surveys, start with the Priority 1 species. This will allow you to get to know your survey area while focusing on a smaller number of plants. When you feel comfortable with your identification skills for the first 11 plants, you can test your ID skills by going on a guided hike with Weed Watchers program. This skills assessment is required if you would like to conduct the more detailed Level 2 survey.

Plant identification training and Level 2 certification is available from the Point Reyes National Seashore Weed Watchers program (contact Jenn_Jordan@nps.gov or call 415-331-5023).

Survey Method
After you have selected a survey location and have familiarized yourself with the plants to search for, you are ready to conduct a survey. Surveys are conducted along walking trails and roadways. You will intensively be looking for weeds on *5 meters* (15 feet) on either side of the survey route, and also scanning the hills and drainages on either side of the route. Try to stop every 100 meters (328 feet, or about the length of a football field) to scan your surroundings. Many discoveries occur when taking a break.

To reduce your impact on the area, please restrict your survey route to park trails. If you need to investigate a plant further from the trail, use binoculars to get a better look.

Survey Instructions: What is a plant occurrence?
When you encounter a plant that you identify as one of the targets, take a moment to look around and see if there are more plants around. You will be recording the number of patches, or *occurrences,* of each plant that you find, rather than the number of individual plants that you find. A plant patch consists of all plants of the same species within 20 m of the next closest plant. The number of plants in each patch will vary depending on the species that you come across. Once you find a plant, walk 20 m along the trail in each direction, and just visually survey off trail. Once you are able to go 20m without finding another plant in any direction, then you will be able to call the patch a single occurrence. This convention will help you save time while mapping.

For each plant that you encounter from Priority List 1 and 2 create an ***occurrence point*** at the center of the patch either with a GPS or on your paper map. At each ***occurrence point*** create a point on your paper survey map and record the information on the Weed Watcher Survey Form 1 or if you are using a GPS unit then record the information found under the Level 2 Survey Section on Weed Watcher Survey Form 2

Handheld GPS units are available for use during Weed Watcher survey outings. These GPS units have the mobile geographic information systems (GIS) and field mapping software, ESRI ArcPad, and the GeoWeed programs loaded onto them. These programs make it easy to record the location of the plants you find, and to digitally record your survey data. Contact the Weed Watchers program for more information about learning about GPS units and digital data collection.

Please follow these instructions for your Level 1 Weed Watcher survey!

Instructions for invasive plant surveys for all Priority 1 Weed Watcher plants, using Survey Form 1 and paper survey maps. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

Make sure that you have the necessary equipment with you.

- Survey Form 1
- Extra pencils or pens
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions
- Camera (*optional*)
- Binoculars
- GPS (*optional*)
- Field notebook and/or blank paper
- First Aid Kit (*optional*)
- Cell phone (for emergencies)

Survey Form 1:

Species name- Genus and species- find in the 1st two columns
 # Occurrences- keep tally marks for each separate occurrence
Location details- directions and distinguishing landmarks that will help others find the plant. Use cardinal directions (N,S,E,W) and distances to describe the directions, also include **Grid Location-** refer to the right and bottom of the paper map to determine (for example: D-4). **Other Info**- If it seems appropriate you can also include info about the size of the patch or the number of plants within the patch if they are easy to count.

Also mark all infestations found on paper map.

Negative Data for Level 1 Weed Watchers:
Negative data is important so that we know which plants are **NOT** found in certain locations. If you are confident that there are Priority 1 species that were not in your survey area, please note this by putting a 0 in the # of occurrences column on Survey Form 1 for each of these species.

At the end of your survey, mark your route on your map with a colored marker and fill out Survey Form 1. Include directions to the site and survey route in the ***trip report***, the total number of occurrences for each of the plants you did and didn't see, and location notes so we can find them on the map. Don't forget to fill out your name and contact information, and time spent on both Survey Forms

Return your data sheets to: (A self-addressed stamped envelope is available upon request.)
Weed Watchers
NPS Inventory & Monitoring San Francisco Area Network
Fort Cronkhite Bldg 1063
Sausalito, CA 94965
Email: Jenn_Jordan@nps.gov
Fax: (415) 331-5530
Phone: (415) 331-5023

Safety First!

- **Poison-oak**, a plant know to cause severe dermal irritation, is found throughout the parks. Avoid contact!
- **Deer ticks**, which potentially can carry Lyme disease, are found throughout the park. Use a repellent containing 40% DEET to help deter ticks and always check yourself thoroughly during and after park excursions.
- **Stay on the trail!** This protects sensitive trailside habitats and you from hazardous terrain! Carry a **cell phone** if possible. In case of emergency call 911 or Park Dispatch (415-464-5170)

Poison-oak-
"Leaves of three, let it be"

Please follow these instructions for your Level 2 (Basic)

Weed Watcher survey!

Instructions for invasive plant surveys for all Priority 1 and Priority 2 Weed Watcher plants, using Survey Form 1 and Survey Form 2, and paper survey maps. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

1. Make sure that you have the necessary equipment with you.

- Survey Form 1
- Survey Form 2
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions
- Camera (*optional*)
- Binoculars
- GPS (*optional*)
- Field notebook and/or blank paper
- First Aid Kit (*optional*)
- Cell phone (for emergencies)
- Extra pencils or pens

2. For each Priority 1 and 2 plant encountered record an ***occurrence point*** on your paper map for the center of the patch. Label your point with the first 4 letters of your occurrence name (first 2 letters of the genus and first 2 letters of the species) and the unique occurrence #. Record the following information on Survey Form 2:

- Weed Occurrence Name: Consisting of the six-digit USDA plant code found on the plant list; the four-digit subwatershed code; the date in four-digit year, two-digit month, and two-digit day; and the occurrence number of that plant for that survey. For instance, if you found the third patch of *Carpobrotus edulis* on 14 July 2006 in Subwatershed 1-2 you would record CAED3X01022006071403 **(**USDAPC+SUWA+YYYYMMDD+U#).

- Species name (Genus species or common)

- Notes (location details such as cardinal direction and distance from path; comments on accessibility of plants; size of plants)

- Latitude and longitude (in decimal degrees, e.g. -122.12345, 37.12345)

3. For every Priority 1 plant, and Priority 2 plants whose patch size is smaller than 100 m^2 (10m by 10m; your arm span is likely between 1.5 and 2m long), you will also record some information about the density and distribution of the plants in the patch. To do this, create an ***assessment polygon***. An ***assessment polygon*** is an outline of the perimeter of the patch, created either on a paper map or with a GPS unit. Record the following information about the patch on Form 2:

Assessment

-Location notes- directions and distinguishing landmarks that will help others find the patch. Use cardinal directions (N,S,E,W) and distances to describe the directions.

-Cover Class- (0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%)over the entire infested area delineated by the assessment polygon.

-Size- the length and width of the patch, in meters or feet, based on pacing or a measuring tape.

-Phenology- record whether the plant is bolting (bolt), bud, dead/skeleton (dead), flowering (flow.), mature (mat.), rosette (rose.), seed set, seedling

- # of plants assessed (if possible, for jubata grass, trees, thistles, etc.)

- **Treated** (whether the patch was treated mechanically or chemically

4. At the end of your survey, mark your route on your map with a colored marker and fill out Survey Form 1. Include directions to the site and survey route in the ***trip report***, the total number of occurrences for each of the plants you did and didn't see, and location notes so we can find them on the map. Don't forget to fill out your name and contact information, and time spent on both Survey Forms 1 and 2.

5. Send us your survey! Don't forget to send us:

- Survey map
- Survey Form 1
- Survey Form 2

Questions? Comments?

Weed Watchers
NPS Inventory & Monitoring San Francisco Area Network
Fort Cronkhite Bldg 1063
Sausalito, CA 94965
Fax: (415) 331-5530
Phone: (415) 331-5023
Email: Jenn_Jordan@nps.gov

Please follow these instructions for your Level 2 (Advanced) Weed Watcher survey!

Instructions for invasive plant surveys for all Weed Watcher plants, using Survey Form 1 and Survey Form 2, paper survey maps, and a GPS unit loaded with GeoWeed. Please refer to the Weed Watcher manual introduction for a detailed description of the Weed Watcher program and survey methodology.

1. Make sure that you have the necessary equipment with you.

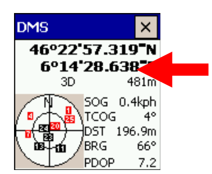
- Survey Form 1
- Survey Form 2
- Paper map(s) of your area (available from Weed Watcher program)
- ID cards (available from Weed Watcher program) and/or field guides
- Instructions
- Camera (*optional*)
- Binoculars
- First Aid Kit (*optional*)
- Field notebook and/or blank paper
- Extra pencils or pens
- Cell phone (for emergencies)
- GPS with background maps and GeoWeed area data (exported from desktop database)

2. Start the ArcPad program on your PDA (***Start> ArcPad 7.01***). Load the GeoWeed occurrence, assessment, survey, and treatment shapefiles (***Add Layers [ ]***. Click on to open My Computer, click on the + next to ***Documents and Settings,*** highlight ***GeoWeed*** and click **OK*,*** put a check in all 4 boxes √ for ***AreaSurveys, Weedassessments, Weedoccurrences, Weedtreatments***. Click on ***OK***. These layers will take a couple of minutes to load, so just wait without touching the pad. Then, load your background maps (***Add Layers [ ]> Documents and Settings> arcpadimagery> subwatershed#> OK***).

If PDA has an SD card, click on that + SD, then √ **arcpad_imagery** and click on the + of the specific watershed. When it asks if the layers should be in WGS84, click on YES.

3. For the Garmin IQue: Turn on the GPS by lifting up the antenna on the back of the unit by pulling down on the back sliding button and pressing the “GPS Position Window” button ( ).

For the Trimble Juno ST: Turn on the GPS by clicking the ( ) button. Then answer ***Yes*** when it asks “Would you like to activate it now?”



You will see a red circle with a yellow cross in the middle of the map when the unit is receiving GPS satellite reception.

You want the GPS points for latitude and longitude to always be in Decimal Degrees. From the GPS Position Window tap on the position coordinate display field until you get drop-down menu. Click on **WGS84 DD GPS**.

4. Enable the GeoWeed toolbar by pressing the GeoWeed key ( )

5. For each Priority 1 and 2 plant encountered record an ***occurrence point*** at the near center of the patch. First activate the GeoWeed occurrence layer ( ). The point may be taken using your current position by pressing the “Capture Point Using GPS” button ( ) or by using the stylus to draw a point on the map by pressing the “Point” button ( ) and then tapping the point on the map. Record the following information:

Basic Tab

- OCC Name: (USDAPC+SUWA+YYYYMMDD+U#)
- Species name (Genus species, drop-down list)
- Data Recorder
- Location notes (directions)
Regions Tab
- **Region 1** (subwatershed from drop-down list)
- Primary designation (check)
- Region 2 (secondary subwatershed or sitename from drop-down list)

Description tab
- Discovery Year (if known)
- Accuracy (GPS 1 is within 10 feet, GPS 2 is within 30 feet)
- **Confidence in Identification/Reason for doubt** (only enter if less than 95% confident in your ID)

6. For each Priority 1 plant patch, and for each Priority 2 plant with a patch < 100 m^2, record an ***assessment polygon*** around the perimeter of the patch. First activate the GeoWeed assessment layer (). Then create a polygon using satellite positions by pressing the "Polygon" button () and then the "Add GPS Vertex" button () and pause at each turn you make while walking around the boundary. Once you have finished collecting points, you must click the  button in order to close the polygon and get to the data entry screen. Alternatively, you can use the stylus to draw a polygon on the map by pressing the "Freehand Polygon" () and then using the stylus to draw a shape around the perimeter of the patch.

Record the following information:

Basic Tab
- Choose Occurrence (occurrence ID Code from the drop-down list)
- Data Recorder (data recorder name from the drop-down list)
- Notes (location directions)

Time
Time for assessment (mandatory) and treatment (if applicable)
- Start time (military time)
- End time (military time)

Size Tab
Note: Size is calculated from the polygon; ONLY enter data if you think that polygon may be incorrect—generally, for very small patches.
(Record accurate patch size, overrides polygon area, use for small patches)
Length x Width
Unit of Measurement
Direct Entry (of area in sq m, sq ft, sq mile, hectare)

Stats Tab
- GPS Accuracy (GPS 1 is within 10 feet, GPS 2 is within 30 feet)
- Area (Primary subwatershed location)
- Phenology (bolting, bud, dead/skeleton, flowering, mature, rosette, seed set, seedling)

Misc Tab
- Cover Class (0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%) for infested area
Also fill out the appropriate spaces on Survey Form 2.

Distribution
Cover Class Desc: Subjective measure of weed distribution.
M = Monoculture, there is nothing but the weed there
U = Uniform distribution and size of weed patches
SA = Satellite, one main patch with smaller, satellite patches
SC = Scattered plants within the same patch
L = Linear distribution
I = Isolated patch

7. At the end of your survey, create a ***survey point*** for the site using the GeoWeed survey button ( ) and the "Capture Point Using GPS" button ( ). You will record the presence or absence of all Priority 1 species encountered on your survey. Record the following information.

Basic Tab
- Area (Primary subwatershed location)
- Land use type (Forest)
- Dominant Veg. Type (e.g. Coastal Scrub or Annual Gramminoids or Forbs)

1-20 Tab
- Note the absence of any of the following List 1 plants not encountered on your survey (do not fill out phenology)

Plumeless thistle	*Carduus acanthoides*	Orange cotoneaster	*Cotoneaster franchetii*
Woolly distaff thistle	*Carthamus lanatus*	Silverleaf cotoneaster	*Cotoneaster pannosa*
Purple starthistle	*Centaurea calcitrapa*	Oblong spurge	*Euphorbia oblongata*
Napa thistle, Tocalote	*Centaurea melitensis*	Licorice plant	*Helichrysum petiolare*
Yellow starthistle	*Centaurea solstitialis*	Klamathweed	*Hypericum perforatum*
		Gorse	*Ulex europaea*

Note: If you are able, record absence information for List 2 or other plants searched for but not seen on your survey, up to 20 plants (see Priority Species List)

8. At the end of your survey, mark your route on your map with a colored marker and finish filling out the presence/absence data on Survey Form 1 for the plants that you did and didn't see. Click on ▼ scroll down and click on **Exit**. Don't forget to completely fill out Survey Form 1 and two including the trip report which describes your survey route, your contact information, and time spent on the survey. Do not record more than one survey before uploading the digital GeoWeed data, as this may lead to data loss.

Decision Tree for Priority 1, 2, and 3 plants

Priority 1 plants	Occurrence and Assessment
Priority 2 plants	Occurrence and Assessment if patch size is less than 100 m^2
	Occurrence only if patch size is greater than 100 m^2
Priority 3 plants	Presence/Absence, or Occurrence if patch size is less than 100 m^2

Questions? Comments?
Weed Watchers
NPS Inventory & Monitoring, SFAN
Fort Cronkhite Bldg 1063
Sausalito, CA 94965
Fax: (415) 331-5530
Phone: (415) 331-5023
Email: Jenn_Jordan@nps.gov

Point Reyes National Seashore Weed Watchers

Invasive Species Early Detection Survey

Survey Form 1 and Site Description

Going for a walk in the park? While you do keep your eye out for these park invaders. If you see a plant from this list, let us know by returning this form to the address at the bottom of the page. All it takes is one visit every other month to the trail of your choice to become a Point Reyes Weed Watcher. Instructions on the other side of this page. Happy Hunting!

Subwatershed ID ___________ Time Start __________ Time Finished ________

Priority 1 Plant	Scientific Name	# Occurrences	Location details (grid #s) and/or plant description
Plumeless Thistle	*Carduus acanthoides*		
Woolly Distaff Thistle	*Carthamus lanatus*		
Purple Starthistle	*Centaurea calcitrapa*		
Tocalote, Napa Starthistle	*Centaurea melitensis*		
Yellow Starthistle	*Centaurea solstitialis*		
Orange Cotoneaster	*Cotoneaster franchetii*		
Silverleaf Cotoneaster	*Cotoneaster pannosa*		
Eggleaf or Oblong Spurge	*Euphorbia oblongata*		
Licorice Plant	*Helicrysum petiolare*		
Kalamathweed	*Hypericum perforatum*		
Gorse, Furze	*Ulex europaea*		

Weed Watchers
Point Reyes National Seashore
1 Bear Valley Road
Point Reyes Station, CA 94956

Jenn_Jordan@nps.gov

www.weedwatcher.org

(415) 331-5023

Point Reyes Weed Watchers

Invasive Species Early Detection Survey

Survey Form 1 Instructions

1. **Make sure that you have the necessary equipment with you.**
   - Weed Watcher Level 1 data and site description form
   - Survey map(s) of your area
   - Color marker
   - Binoculars
   - ID cards and/or field guides
   - First Aid Kit (*optional*)
   - Camera (*optional*)
   - Extra pencils or pens
   - GPS Unit (*optional*)
   - Cell phone (for emergencies)
   - Field notebook and/or blank paper

2. **Conduct your plant survey along roads and trails of Point Reyes National Seashore.** Use the Point Reyes Weed Watcher survey maps and identification cards to help you find a high-priority survey area and to identify the plants on the other side of this form. Survey maps and ID cards are available for download at **http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/weed_watchers.cfm**.

If you have looked at the cards and are still not sure that you found a priority plant, or you think that you have found something unusual, try one of the following:

- ***Take a picture*** of the plant in question. Include a leaf, a flower (if available), and something like a quarter or your hand for a size reference. Send your picture to Andrea_Williams@nps.gov. *Hint*: many cell phones have cameras and the ability to send images to an email address.
- **Write a detailed description** of the plant in question. Include as many details as possible, including details about the leaves (size, shape, alternate/opposite, lobed/entire); the flower (shape, color, size, orientation); size of plant; and habitat found in. *Hint*: Drawing a picture of the plant will help focus your attention on the details.

3. **Fill out this data sheet** and send to the address on the front of this sheet. Let us know what you find!
   - *Trip Report*: **How do I describe where I completed my survey?** Many of the areas in the Point Reyes National Seashore have official and unofficial names. Use the Weed Watcher surveys maps to show your approximate location and write the grid name and a description of the area you surveyed in the space provided. Have a GPS? Give us the latitude and longitude of your starting point, ending point, and pest plants encountered. Want to learn more? Training is available to become a certified Weed Watcher. Contact us to find out about the next weed watcher training hike.

Name ______________________ Phone ______________ Email ________________

Other Observers ________________ Survey Date ________ Time (start- finish) ________

Trip Report (Survey Route, Site Description, Additional Plant Location Details):

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GeoWeed____(date)____(Int)

Point Reyes National Seashore Invasive Species Early Detection Survey Form Survey Form 2	SURVEY AREA ID: DATA RECORDER: OTHER OBSERVERS:		DATE: TIME START: TIME FINISH:
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	
WEED OCCURRENCE NAME (USDAPC+SUWA+YYYYMMDD+U#) / SPECIES NAME	LATITUDE .	LONGITUDE - .	MARKED ON PAPER MAP? Y N NOTES:
ASSESSMENT (ALL PRIOR 1, PRIOR 2 IF < 100M2) COVER CLASS 0%, 0-1%/trace, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100% _____ (#) OF PLANTS ASSESSED Treated? Y N	PATCH SIZE LENGTH ___ (m / ft) X WIDTH ___ (m / ft)	PHENOLOGY bolting, budding, dead, flowering, mature, rosette, seedling, seed set	

Please return these survey forms to National Park Service SFAN Inventory and Monitoring, 1 Bear Valley Rd, Pt Reyes Station, CA 94956 Phone (415) 464-5201 Fax (415) 464-5183

Point Reyes Weed Watcher Priority Plant List June 2009				
List	Scientific Name	Common Name	Family	Sp Code
List 1 (Occurrence and Assessment)	*Carduus acanthoides*	plumeless thistle	Asteraceae	CAACXX
	Carthamus lanatus	woolly distaff thistle	Asteraceae	CALA20
	Centaurea calcitrapa	purple starthistle	Asteraceae	CECA2X
	Centaurea melitensis	Napa thistle, tocalote	Asteraceae	CEME2X
	Centaurea solstitialis	yellow starthistle	Asteraceae	CESO3X
	Cotoneaster franchetii	orange cotoneaster	Roseaceae	COFR3X
	Cotoneaster pannosus	silverleaf cotoneaster	Roseaceae	COPA14
	Euphorbia oblongata	egglear or oblong spurge	Euphorbiaceae	EUOB4X
	Helichrysum petiolare	licorice plant	Asteraceae	HEPE8X
	Hypericum perforatum	Klamathweed	Hypericaceae	HYPEXX
	Ulex europaea	gorse, furze	Fabaceae	ULEUXX
List 2 (Occ. and Assessment if patch <100m2)	*Acacia melanoxylon*	blackwood acacia	Fabaceae	ACMEXX
	Arctotheca calendula	capeweed	Asteraceae	ARCA45
	Berberis darwinii	Darwin's berberis	Berberidaceae	BEDAXX
	Cystisus scoparius	Scotch broom	Fabaceae	CYSC4X
	Datura stramonium	jimsonweed, thorn apple	Solanaceae	DASTXX
	Delairea odorata	cape ivy	Asteraceae	DEODXX
	Echium candicans	pride of Madeira	Boraginaceae	ECCA5X
	Genista monspessulana	French broom	Fabaceae	GEMO2X
	Hedera helix	English ivy	Araliaceae	HEHEXX
	Ilex aquifolium	English holly	Aquifoliaceae	ILAQ80
	Leucanthemum vulgare	ox-eye daisy	Asteraceae	LEVUXX
	Linaria vulgaris	butter and eggs	Scrophulariaceae	LIVU2X
	Pennisetum clandestinum	Kikuyu grass	Poaceae	PECL2X
	Phalaris aquatica	Harding grass	Poaceae	PHAQXX
	Pittosporum undulatum	Victorian box	Pittosporaceae	PIUN2X
	Rubus discolor [procerus]	Himalayan blackberry	Rosaceae	RUDI2X
	Tetragonia tetragonoides	New Zealand-spinach	Aizoaceae	TETE3X
	Vinca major	periwinkle	Apocynaceae	VIMAXX
	Xanthium spinosum	spiny cockleburr	Asteraceae	XASP2X
List 3.1 (Occurrence and Assessment)	*Acroptilon [Centaurea] repens*	Russian knapweed	Asteraceae	ACRE3X
	Aegilops triuncialis	barbed goatgrass	Poaceae	AETRXX
	Ageratina adenophora	thoroughwort, crofton weed	Asteraceae	AGAD2X
	Albizia lophantha	silk tree, cape wattle	Fabaceae	ALLOXX
	Anthoxanthum odoratum	sweet vernalgrass	Poaceae	ANODXX
	Brachypodium distachyon	purple false brome	Poaceae	BRDI2X
	Centaurea iberica	Iberian starthistle	Asteraceae	CEIBXX
	Dittrichia graveolens	stinkweed	Asteraceae	DIGR4X
	Ehrharta calycina	perennial veldt grass	Poaceae	EHCAXX
	Marrubium vulgare	horehound	Lamiaceae	MAVUXX
	Paspalum dilatum	dallis grass	Poaceae	PADI3X
	Robinia pseudoacacia	black locust	Fabaceae	ROPSXX
	Salsola soda	oppositeleaf Russian thistle	Chenopodiaceae	SASO3X
	Senecio jacobaea	tansy ragwort, stinking willie	Asteraceae	SEJAXX

Point Reyes Weed Watcher Priority Plant List June 2009

List	Scientific Name	Common Name	Family	Sp Code
List 3 (Occurrence if <100m2 or presence/absence)	*Acacia longifolia*	Sydney golden wattle	Fabaceae	ACLOXX
	Acacia verticillata	prickly Moses	Fabaceae	ACVE2X
	Carpobrotus chilensis	sea fig	Aizoaceae	CACH38
	Carpobrotus edulis	hottentot fig, freeway iceplant	Aizoaceae	CAED3X
	Conium maculatum	poison hemlock	Apiaceae	COMA2X
	Cortaderia jubata	Andean or purple pampas grass, jubata grass	Poaceae	COJU2X
	Cortaderia selloana	Uruguayan pampas grass	Poaceae	COSE4X
	Cotoneaster lacteus	milkflower cotoneaster	Rosaceae	COLA18
	Crataegus monogyna	singleseed hawthorn	Rosaceae	CRMOXX
	Cupressus macrocarpa	Monterey cypress	Cupressaceae	CUMA2X
	Digitalis purpurea	purple foxglove	Scrophulariaceae	DIPUXX
	Dipsacus fullonum	common or Fuller's teasel	Dipsacaceae	DIFU2X
	Dipsacus sativus	indian teasel	Dipsacaceae	DISA9X
	Drosanthemum floribundum	showy dewflower	Aizoaceae	DRFL2X
	Echium plantagineum	salvation jane	Boraginaceae	ECPLXX
	Ehrharta erecta	panic veldt grass	Poaceae	EHERXX
	Eucalyptus globulus	bluegum eucalyptus	Myrtaceae	EUGLXX
	Euphorbia lathyris	gopher plant, caper spurge	Euphorbiaceae	EULA4X
	Festuca arundinacea	tall fescue	Poaceae	FEAR3X
	Foeniculum vulgare	sweet fennel	Apiaceae	FOVUXX
	Hypericum calycinum	Aaron's beard	Clusiaceae	HYCA10
	Lythrum hyssopifolia	hyssop loosestrife	Lythraceae	LYHY2X
	Mentha pulegium	pennyroyal	Lamiaceae	MEPUXX
	Myoporum laetum	myoporum	Myoporaceae	MYLA5X
	Pinus radiata	Monterey pine	Pinaceae	PIRA2X
	Populus alba	white poplar	Salicaceae	POAL7X
	Pyracantha angustifolia	narrowleaf firethorn	Rosaceae	PYANXX
	Rosa eglanteria	sweetbriar rose	Rosaceae	ROEGXX
	Scabiosa atropurpurea	mourningbride	Dipsacaceae	SCATXX
	Sorghum halepense	Johnson grass	Poaceae	SOHAXX
	Tanacetum parthenium	feverfew	Asteraceae	TAPA6X
	Verbascum blattaria	moth mullein	Scrophulariaceae	VEBLXX
	Watsonia meriana	bulbil bugle-lily	Iridaceae	WAMEXX
	Zantedeschia aethiopica	calla lily	Araceae	ZAAEXX

Point Reyes Weed Watcher Priority Plant List June 2009

List	Scientific Name	Common Name	Family	Sp Code
List 4 (Presence/absence only)	*Agrostis avenacea*	Pacific bentgrass	Poaceae	AGAVXX
	Agrostis capillaris	colonial bentgrass	Poaceae	AGCA5X
	Agrostis stolonifera	creeping bentgrass	Poaceae	AGST2X
	Agrostis viridis	green bent	Poaceae	AGVI11
	Anthemis cotula	chamomile, dog fennel	Asteraceae	ANCO2X
	Aptenia cordifolia	heartleaf iceplant	Aizoaceae	APCOXX
	Avena barbata	slender oat	Poaceae	AVBAXX
	Avena fatua	wild oat	Poaceae	AVFAXX
	Bellardia trixago	bellardia	Scrophulariaceae	BETRXX
	Brassica nigra	black mustard	Brassicaceae	BRNIXX
	Brassica rapa	field mustard	Brassicaceae	BRRAXX
	Briza maxima	big quakinggrass	Poaceae	BRMAXX
	Briza minor	little quakinggrass	Poaceae	BRMI2X
	Bromus diandrus	ripgut brome	Poaceae	BRCA6X
	Bromus hordeaceus	soft brome	Poaceae	BRHO2X
	Bromus madritensis ssp. rubens	red brome	Poaceae	BRMARX
	Carduus pycnocephalus	Italian thistle	Asteraceae	CAPY2X
	Carduus tenuiflorus	slender-flowered thisle	Asteraceae	CATE2X
	Cichorium intybus	chicory	Asteraceae	CIINXX
	Cirsium vulgare	bull thistle	Asteraceae	CIVUXX
	Convolvulus arvensis	field bindweed	Convolvulaceae	COAR4X
	Crocosmia X crocosmiiflora	crocosmia, montbretia	Iridaceae	CRCR6X
	Cynosurus echinatus	bristly dogstail grass, hedgehog dogtail	Poaceae	CYECXX
	Dactylis glomerata	orchard grass, cocksfoot	Poaceae	DAGLXX
	Erechtites glomerata	Australian fireweed, cutleaf burnweed	Asteraceae	ERGL8X
	Erechtites minima	Australian fireweed, coastal burnweed	Asteraceae	ERMI6X
	Geranium dissectum	cutleaf geranium	Geraniaceae	GEDIXX
	Hirschfeldia incana	shortpod mustard	Brassicaceae	HIIN3X
	Holcus lanatus	velvet grass, Yorkshire fog	Poaceae	HOLAXX
	Hordeum marinum ssp. gussonianum	Mediterannean barley	Poaceae	HOMAGX
	Hordeum murinum	mouse barley	Poaceae	HOMUXX
	Hypochaeris glabra	smooth catsear	Asteraceae	HYGL2X
	Hypochaeris radicata	hairy cat's ear, false dandelion	Asteraceae	HYRA3X
	Leontodon taraxacoides ssp.longirostris	lesser hawkbit	Asteraceae	LETALX
	Lepidium strictum	upright pepperweed	Brassicaceae	LEST2X
	Leucanthemum maximum	Shasta daisy and hybrids	Asteraceae	LEMA8X
	Lolium multiflorum	Italian or annual ryegrass	Poaceae	LOMUXX
	Lolium perenne	Italian or perennial ryegrass	Poaceae	LOPEXX
	Lotus corniculatus	Birdsfoot trefoil	Fabaceae	LOCO6X

Point Reyes Weed Watcher Priority Plant List June 2009				
List	Scientific Name	Common Name	Family	Sp Code
List 4 (Presence/absence only)	*Medicago polymorpha*	California burclover	Fabaceae	MEPO3X
	Melilotus alba	white sweetclover	Fabaceae	MEAL2X
	Meliotus indica	sourclover	Fabaceae	MEIN2X
	Picris echioides	bristly oxtongue	Asteraceae	PIECXX
	Plantago lanceolata	English or lanceleaf plantain, ribgrass	Plantaginaceae	PLLAXX
	Poa pratensis ssp. pratensis	Kentucky bluegrass	Poaceae	POPRP2
	Polypogon monspeliensis	rabbitfoot beardgrass	Poaceae	POMO5X
	Raphanus raphanistrum	wild radish	Brassicaceae	RARA2X
	Raphanus sativus	wild radish	Brassicaceae	RASA2X
	Rosa canina	dog rose	Rosaceae	ROCA3X
	Rumex acetosella	sheep sorrel	Polygonaceae	RUAC3X
	Rumex crispus	curly dock	Polygonaceae	RUCRXX
	Silene gallica	windmill catchfly	Caryophyllaceae	SIGAXX
	Silybum marianum	blessed milkthistle	Asteraceae	SIMA3X
	Solanum nigrum	black nightshade	Solanaceae	SONIXX
	Sonchus arvensis	perennial sowthistle	Asteraceae	SOAR2X
	Trifolium hirtum	rose clover	Fabaceae	TRHI4X
List 5.1 (Occurrence and Assessment)	*Alisma lanceolatum*	lanceleaf water plantain	Alismataceae	ALLA2X
	Arundo donax	giant reed	Poaceae	ARDO4X
	Conicosia pugioniformis	narrow-leaved iceplant	Aizoaceae	COPU18
	Egeria densa	Brazilian elodea or waterweed	Hydrocharitaceae	EGDEXX
	Iris pseudacorus	yellow flag	Iridaceae	IRPSXX
	Lepidium latifolium	perennial pepperweed, tall whitetop	Brassicaceae	LELA2X
	Ludwigia peploides	floating primrose-willow	Onagraceae	LUPE5X
	Myriophyllum aquaticum	parrot's-feather	Haloragaceae	MYAQ2X
	Phalaris arundinacea	reed canary grass	Poaceae	PHAR3X
	Spartina alterniflora	Atlantic, saltmarsh, or smooth cordgrass	Poaceae	SPALXX
5.3	*Ammophila arenaria*	European beachgrass	Poaceae	AMAR4X
5.4	*Cakile edentula*	European searocket	Brassicaceae	CAEDXX
5.4	*Cakile maritima*	European searocket	Brassicaceae	CAMAXX
W2	*Oxalis pes-caprae*	Bermuda buttercup	Oxalidaceae	OXPEXX
W3	*Allium triquetrum*	threecorner leek	Liliaceae	ALTR4X
W3	*Sparaxis tricolor*	harlequinflower, wandflower	Iridaceae	SPTRXX
W4	*Romulea rosea var. australis*	rosy sandcrocus	Iridaceae	ROROAX

Pinnacles Weed Watcher Priority Plant List June 2009				
List	Scientific Name	Common Name	Family	Sp Code
List 1 (Occurrence and Assessment)	*Acroptilon [Centaurea] repens*	Russian knapweed	Asteraceae	ACRE3X
	Lepidium latifolium	perennial pepperweed, tall whitetop	Brassicaceae	LELA2X
	Melilotus alba	white sweetclover	Fabaceae	MEAL2X
	Nicotiana glauca	tree tobacco	Solanaceae	NIGLXX
	Rubus discolor [procerus]	Himalayan blackberry	Rosaceae	RUDI2X
	Salsola tragus	prickly Russian thistle	Chenopodiaceae	SATR12
	Taeniatherum caput-medusae	Medusahead	Poaceae	TACA8X
	Verbascum thapsus	woolly mullein	Scrophulariaceae	VETHXX
List 2 (Occ. and Assess. <100m2)	*Carduus pycnocephalus*	Italian thistle	Asteraceae	CAPY2X
	Carduus tenuiflorus	slender-flowered thisle	Asteraceae	CATE2X
	Conium maculatum	poison hemlock	Apiaceae	COMA2X
	Cynodon dactylon	Bermudagrass	Poaceae	CYDAXX
	Marrubium vulgare	horehound	Lamiaceae	MAVUXX
List 3.1 (Occurrence and Assessment)	*Ailanthus altissima*	tree-of-heaven	Simaroubaceae	AIALXX
	Chenopodium ambrosioides	Mexican-tea	Chenopodiaceae	CHAMXX
	Dittrichia graveolens	stinkweed	Asteraceae	DIGRXX
	Lolium multiflorum	Italian or annual ryegrass	Poaceae	LOMUXX
	Lolium perenne	Italian or perennial ryegrass	Poaceae	LOPEXX
	Lolium temulentum	darnel	Poaceae	XASP2X
	Malva parviflora	cheeseweed	Malvaceae	MAPA5X
	Picris echioides	bristly oxtongue	Asteraceae	PIECXX
	Piptatherum miliaceum	smilo grass	Poaceae	PIMI3X
	Poa bulbosa	bulbous bluegrass	Poaceae	POBUXX
	Tragopogon dubius	yellow salsify, goat's beard, oyster plant	Asteraceae	TRDUXX
	Tribulus terrestris	puncturevine	Zygophyllaceae	TRTEXX
	Trifolium hirtum	rose clover	Fabaceae	TRHI4X
	Verbascum blattaria	moth mullein	Scrophulariaceae	VEBLXX
	Xanthium spinosum	spiny cockleburr	Asteraceae	XASP2X
List 3 (Occurrence if <100m2, or presence/absence	*Amaranthus albus*	tumbleweed	Amaranthaceae	AMALXX
	Brassica nigra	black mustard	Brassicaceae	BRNIXX
	Brassica rapa	field mustard	Brassicaceae	BRRAXX
	Centaurea melitensis	Napa thistle, tocalote	Asteraceae	CEME2X
	Centaurea solstitialis	yellow starthistle	Asteraceae	CESO3X
	Cirsium vulgare	bull thistle	Asteraceae	CIVUXX
	Hirschfeldia incana	shortpod mustard	Brassicaceae	HIIN3X
	Lactuca serriola	prickly lettuce	Asteraceae	LASEXX
	Mentha spicata var. spicata	spearmint	Lamiaceae	MESP3X
	Mentha X piperita	peppermint	Lamiaceae	MEPIXX
	Plantago lanceolata	English or lanceleaf plantain, ribgrass	Plantaginaceae	PLLAXX
	Polygonum arenastrum	oval-leaf knotweed	Polygonaceae	POAR11
	Raphanus sativus	wild radish	Brassicaceae	RASA2X
	Rumex acetosella	sheep sorrel	Polygonaceae	RUAC3X
	Rumex crispus	curly dock	Polygonaceae	RUCRXX
	Silybum marianum	blessed milkthistle	Asteraceae	SIMA3X

Pinnacles Weed Watcher Priority Plant List June 2009				
List	Scientific Name	Common Name	Family	Sp Code
List 4 (Presence/Absence only)	*Amaranthus retroflexus*	redroot amaranth	Amaranthaceae	AMREXX
	Anthemis cotula	chamomile, dog fennel	Asteraceae	ANCO2X
	Artemisia biennis	biennial wormwood	Asteraceae	ARBI2X
	Avena barbata	slender oat	Poaceae	AVBAXX
	Avena fatua	wild oat	Poaceae	AVFAXX
	Bromus arenarius	Australian brome	Poaceae	BRAR3X
	Bromus diandrus	ripgut brome	Poaceae	BRDI3X
	Bromus hordeaceus	soft brome	Poaceae	BRHO2X
	Bromus madritensis ssp. rubens	red brome	Poaceae	BRMARX
	Bromus trinii	Chilean chess	Poaceae	BRTR2X
	Capsella bursa-pastoris	shepherd's-purse	Brassicaceae	CABU2X
	Chamaesyce maculata	spotted spurge	Euphorbiaceae	CHMA15
	Chamomilla suaveolens	pineappleweed	Asteraceae	CHSU5X
	Chenopodium album	lambsquarters, goosefoot	Chenopodiaceae	CHAL7X
	Cynosurus echinatus	bristly dogstail grass, hedgehog dogtail	Poaceae	CYECXX
	Erodium botrys	longbeak stork's bill	Geraniaceae	ERBOXX
	Erodium brachycarpum	shortfruit stork's bill	Geraniaceae	ERBR14
	Erodium cicutarium	redstem filaree	Geraniaceae	ERCI6X
	Erodium moschatum	musky stork's bill	Geraniaceae	ERMO7X
	Filago [Logfia] gallica	narrowleaf cottonrose	Asteraceae	FIGAXX
	Gastridium ventricosum	nit grass	Poaceae	GAVE3X
	Geranium dissectum	cutleaf geranium	Geraniaceae	GEDIXX
	Gnaphalium luteoalbum	Jersey cudweed	Asteraceae	GNLUXX
	Herniaria hirsuta ssp. cinerea	hairy rupturewort	Caryophyllaceae	HEHICX
	Hypochaeris glabra	smooth catsear	Asteraceae	HYGL2X
	Hypochaeris radicata	hairy cat's ear, false dandelion	Asteraceae	HYRA3X
	Lythrum hyssopifolia	hyssop loosestrife	Lythraceae	LYHY2X
	Medicago polymorpha	California burclover	Fabaceae	MEPO3X
	Melilotus indica	sourclover	Fabaceae	MEIN2X
	Nicotiana acuminata var. multiflora	manyflower tobacco	Solanaceae	NIACMX
	Plantago major	broadleaf or common plantain	Plantaginaceae	PLMA2X
	Polycarpon tetraphyllum	fourleaf manyseed	Caryophyllaceae	POTEXX
	Polypogon interruptus	ditch rabbit's-foot grass	Poaceae	POIN7X
	Polypogon monspeliensis	rabbitfoot beardgrass	Poaceae	POMO5X
	Portulaca oleracea	purslane	Portulacaceae	POOLXX
	Silene gallica	windmill catchfly	Caryophyllaceae	SIGAXX
	Sisymbrium orientale	oriental hedgemustard	Brassicaceae	SIOR4X
	Spergula arvensis ssp. arvensis	corn spurry	Caryophyllaceae	SPARXX

Appendix SOP 3 B. A detectability index and calendar for invasive plants at Point Reyes and Golden Gate.

Some species are more visible than others; some are more visible at certain times of the year. Unlike other calendars based solely on flowering, the one below attempts to factor in the stature of the pest plant; the habitat in which it is generally found; and the contrast between the two during each month of the year. Filled in for many of the exotic species found at Point Reyes and Golden Gate, it should serve as a starting point for optimizing survey timing. It will be refined according to field observations. Note that detectabilities are based on being able to spot a 10-meter-square patch size, not necessarily to species (if you can tell it's a weedy mustard at 30m, for example, but not whether it's *Hirschfeldia incana* or *Brassica*, detectability is still a 3). Of course, detectability for a given patch increases over time, as individuals or clumps grow larger. Visibility will also vary between habitats, for species found in many habitats. Not all criteria need to be met for each ranking.

0=senescent, dead; aboveground biomass little to none; +/- undistinguishable from surrounding veg
1=emergent, small; dead aboveground biomass conspicuous; difficult to distinguish from surrounding vegetation (<1m) (e.g. velvet grass in October--bleached, and hard to tell from all the other grasses)
2=stature or coloring differs from surrounding veg; distinguishable at <20m (e.g. velvet grass in June, or brooms when not flowering)
3=high contrast from surrounding vegetation; generally fl/fr; distinguishable at >>20m (e.g. flowering broom)

Species	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia baileyana	cootamundra wattle	3	3	3	3	2	2	2	2	2	2	2	2
Acacia dealbata	silver wattle	3	3	3	3	2	2	2	2	2	2	2	2
Acacia decurrens	green wattle	3	3	3	3	2	2	2	2	2	2	2	2
Acacia longifolia	Sydney golden wattle	3	3	3	3	2	2	2	2	2	2	2	2
Acacia mearnsii	black wattle	3	3	3	3	2	2	2	2	2	2	2	2
Acacia melanoxylon	blackwood acacia	3	3	3	3	3	3	3	3	3	3	3	3
Acacia verticillata	prickly Moses	3	3	3	3	2	2	2	2	2	2	2	2
Ageratina adenophora	thoroughwort, crofton weed	2	2	3	3	3	2	1	1	1	1	1	2
Ailanthus altissima	tree-of-heaven	1	1	1	2	2	2	2	2	1	1	1	1
Amaryllis belladonna [*Brunsvigia rosea*]	belladonna lily	1	1	2	2	3	3	3	3	2	1	0	0
Ammophila arenaria	European beachgrass	2	2	2	2	1	1	1	1	1	2	2	2
Ammophila breviligulata	American beachgrass	2	2	2	2	1	1	1	1	1	2	2	2

0=senescent, dead; aboveground biomass little to none; +/- undistinguishable from surrounding veg
1=emergent, small; dead aboveground biomass conspicuous; difficult to distinguish from surrounding vegetation (<1m) (e.g. velvet grass in October--bleached, and hard to tell from all the other grasses)
2=stature or coloring differs from surrounding veg; distinguishable at <20m (e.g. velvet grass in June, or brooms when not flowering)
3=high contrast from surrounding vegetation; generally fl/fr; distinguishable at >>20m (e.g. flowering broom)

Species	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendula arvensis	field marigold	3	3	3	2	1	0	0	0	0	0	0	1
Carduus acanthoides	giant plumeless thistle	0	0	1	2	3	3	3	3	2	1	0	0
Carduus pycnocephalus	Italian thistle	0	1	2	3	3	3	3	2	0	0	0	0
Carpobrotus edulis	highway iceplant	2	2	2	3	3	3	3	2	2	2	2	2
Carthamus lanatus	distaff thistle	0	0	0	0	1	2	3	3	3	2	1	0
Centaurea calcitrapa	purple starthistle	0	0	0	0	1	2	3	3	2	1	1	1
Centaurea melitensis	Napa thistle, tocalote	0	0	1	1	2	3	3	3	3	3	2	1
Centaurea solstitialis	yellow starthistle	0	0	1	1	2	3	3	3	3	2	2	1
Cirsium vulgare	bull thistle	0	0	1	1	2	3	3	3	2	1	0	0
Conium maculatum	poison hemlock	1	2	2	3	3	3	3	2	0	0	0	1
Cortadera jubata	jubata grass	2	2	2	2	2	2	3	3	3	3	2	2
Cortaderia selloana	Uruguayan pampas grass	2	2	2	2	2	2	2	2	3	3	3	2
Cotoneaster franchetii	orange cotoneaster	2	2	2	2	2	2	2	2	3	3	3	3
Cotoneaster pannosus	silverleaf cotoneaster	3	2	2	2	2	2	2	2	3	3	3	3
Cotoneaster sp.	cotoneaster	2	2	2	2	2	2	2	2	3	3	3	3
Crataegus monogyna	singleseed hawthorn	2	2	3	3	3	2	1	1	1	1	1	1
Crocosmia x *crocosmiiflora*	crocosmia, montbretia	2	3	3	2	2	1	0	0	0	0	0	1
Cupressus macrocarpa	Monterey cypress	3	3	3	3	3	3	3	3	3	3	3	3
Cynodon dactylon	Bermudagrass	1	1	1	1	1	1	1	1	1	1	1	1
Cytisus scoparius	Scotch broom	2	3	3	3	2	2	2	2	2	2	2	2
Cytisus striatus	Portugese broom	2	2	3	3	3	2	2	2	2	2	2	2

0=senescent, dead; aboveground biomass little to none; +/- undistinguishable from surrounding veg

1=emergent, small; dead aboveground biomass conspicuous; difficult to distinguish from surrounding vegetation (<1m) (e.g. velvet grass in October--bleached, and hard to tell from all the other grasses)
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3=high contrast from surrounding vegetation; generally fl/fr; distinguishable at >>20m (e.g. flowering broom)

Species	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Delaria odorata	cape ivy	3	3	2	2	1	1	1	1	1	2	2	3
Digitalis purpurea	foxglove	0	0	1	1	2	3	3	2	1	0	0	0
Dipsacus fullonum	common or Fuller's teasel	1	1	1	2	2	2	2	2	1	1	1	1
Dittrichia graveolens	stinkwort	1	0	0	0	0	0	0	1	2	2	2	1
Ehrharta erecta	panic veldt grass	0	1	1	2	2	2	2	1	1	1	1	0
Eucalyptus globulus	bluegum eucalyptus	3	3	3	3	3	3	3	3	3	3	3	3
Euphorbia oblongata	oblong spurge	0	1	2	3	3	3	3	2	1	0	0	0
Foeniculum vulgare	fennel	3	3	2	1	1	1	1	1	1	2	2	3
Genista monspessulana	French broom	2	2	3	3	3	3	2	2	2	2	2	2
Hedera canariensis	Algerian ivy	3	3	2	2	2	2	2	2	2	2	2	3
Hedera helix	English Ivy	3	3	2	2	2	2	2	2	2	2	2	3
Helichrysum petiolare	licorice plant	1	1	1	1	1	1	1	1	2	2	2	2
Hirschfeldia incana	shortpod mustard	0	0	1	2	3	3	2	1	1	1	0	0
Holcus lanatus	velvet grass	1	2	2	3	3	3	3	2	1	1	1	1
Hypericum perforatum	Klamathweed	0	0	0	1	2	3	3	2	1	0	0	0
Ilex aquifolium	English holly	1	1	1	1	1	1	1	1	1	1	1	1
Leptospermum laevigatum	Australian teatree	2	3	3	2	2	2	2	2	2	2	2	2
Leucanthemum maximum	Shasta daisy and hybrids	0	0	1	1	2	3	3	2	1	0	0	0
Leucanthemum vulgare	Ox-eye daisy	0	0	1	1	2	3	3	2	1	0	0	0
Mentha pulegium	pennyroyal	1	1	1	1	1	2	2	3	3	2	1	1
Oxalis pes-caprae	Bermuda buttercup	3	3	3	2	2	1	0	0	0	0	1	2
Pennisetum clandestinum	Kikuyu grass	1	1	1	1	1	2	2	2	2	2	1	1

0=senescent, dead; aboveground biomass little to none; +/- undistinguishable from surrounding veg
1=emergent, small; dead aboveground biomass conspicuous; difficult to distinguish from surrounding vegetation (<1m) (e.g. velvet grass in October--bleached, and hard to tell from all the other grasses)
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3=high contrast from surrounding vegetation; generally fl/fr; distinguishable at >>20m (e.g. flowering broom)

Species	Common Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phalaris aquatica	Harding grass	1	1	1	1	1	2	2	2	2	1	1	1
Pinus radiata	Monterey pine	2	2	2	2	2	2	2	2	2	2	2	2
Prunus avium	bird cherry	1	2	2	2	1	1	1	1	1	1	1	1
Prunus cerasifera	cherry plum	1	2	2	2	1	1	1	1	1	1	1	1
Pyracantha angustifolia	narrowleaf firethorn	2	2	2	2	3	3	3	3	3	3	2	2
Robinia pseudoacacia	black locust	1	1	2	3	3	3	2	2	2	2	1	1
Rubus discolor [*procerus*]	Himalayan blackberry	2	2	2	2	2	2	3	3	3	2	2	2
Rumex acetosella	sheep sorrel	0	0	0	1	1	2	2	2	1	0	0	0
Schinus molle	pepper tree	2	2	2	2	2	3	3	3	2	2	2	2
Sparaxis tricolor hybrid	Harlequin flower	1	2	3	3	2	1	0	0	0	0	0	0
Ulex europaea	gorse, furze	2	2	3	3	3	2	2	2	2	2	2	2
Vinca major	periwinkle	2	2	3	3	2	2	2	2	2	2	2	2

Appendix SOP 3 C. Inventory data sheet.

SURVEY AREA ID: DATE:

DATA RECORDER:

OTHER OBSERVERS:

AREA DESCRIPTION AND ACCESS DIRECTIONS:

SPECIES SEEN: (CIRCLE IF OCCURRENCE FOR SP)

TREES:	SHRUBS:	FORBS:	FORBS:	
GRASSES & ALLIES:				
	FERNS & ALLIES:			

Note that the lifeforms listed above for notational convenience do not correspond exactly with guilds used for ranking and map symbolization.

Standard Operating Procedure (SOP) 4: Plant Collecting and Vouchering. Version 1.1 (May 2008)

Based on Redwood National and State Parks Plant Collecting And Specimen Vouchering: Procedures And Techniques. April 2003, Andrea Williams; revision of June 1994 guidelines by Stassia Samuels

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	5/1/2007	Williams, A.	Adapted to protocol, added NPSpecies info	For protocol not Redwood	1.0
1.0	5/8/2008	Williams, A.	Added numbers, expanded TOC	Conform to NRTR guidelines	1.1

Contents

Contents (continued)

Figures

Tables

1.0 Introduction

Having a physical voucher of a plant, especially a potentially new record in the park, is still the preferred method of proving an observation. Specimens, even non-natives, should not be collected by non-staff unless the individual has the proper Scientific Research and Collecting Permit. Volunteers and inexperienced observers should only take photographic vouchers of any unknown species. More experienced staff may field-key or choose to voucher for expert identification, or to record a new species for the park plant list or significant range expansion for an invasive species (*e.g.*, the first record in the county), but should also photograph the plant *in situ* to capture characteristics that may be lost during pressing. Contact park vegetation staff for a list of plants that lack voucher evidence of their presence in the park.

Only PARK STAFF are allowed to collect without a permit.

2.0 In the Field

2.1 Collecting Ethics and Regulations

Only collect if the plant's population will not be seriously affected by the taking: generally, if there are over 20 individuals in the vicinity. If the population is small, but you must collect, take only enough to key without destroying the plant (*e.g.*, a flower and/or stem without roots) and consider photo-vouchering. If plants are, or are suspected to be, rare, consider carefully whether or not to collect. CNPS, State and Federally listed species should not be collected without consultation with the park Supervisory Botanist and the appropriate permits.

2.2 Collecting Tips

Plants are best keyed fresh, so field-key when possible. Tiny-flowered plants are especially difficult to key when wilted or pressed. If field-keying is unsuccessful, press some and bag some in a plastic baggie. Blow it up with air and keep it moist (a small piece of wet paper in the bag helps); refrigeration will help keep your specimen fresh. Remember to label both the bagged and the pressed plants! A plastic sandwich container will also work well for delicate structures.

If you decide to collect with the intent of creating a pressed and mounted specimen:

Collect a representative example of the species, not the largest or smallest. Try to capture any phenotypic variation.

Collect enough of the plant to make pressing worthwhile. If the plants are tiny, collect enough to fill about half an herbarium sheet. Take enough to make a good voucher, plus a little extra for keying if necessary.

Collect as much of the individual plant as possible, including roots (or a portion if rhizomatous), bulbs, vegetative and flowering/fruiting matter.

Collect as many phenological stages as possible (flowering and fruiting), since many keys use characteristics of fruit and flower. If necessary, snip flowers or fruits off an additional plant to complete the collection.

Press carefully, the standard plant press is the same size as a standard herbarium sheet (11"x17"). How you place the plant in the press will generally be how it will look mounted. If a plant is large, fold it or cut it to fit, keeping branchings and general form intact. Note original dimensions and photograph if possible. Plants may occasionally require more than one sheet for proper representation.

Take copious notes, including the following information (see field descriptions from NPSpecies below): date; collector; exact location in Lat/Long or UTM (from GPS–if GPS is used, specify datum such as NAD83); descriptive location (*e.g.* Wolf Ridge, Marin Headlands; do not use "local" nicknames not on any map!); habitat description (dominant species); associated species; characteristics that may be lost in pressing (smells, flower color, habit, etc.); study name and number/plot number if applicable. Some information (elevation, sensitivity) may be filled in at the office. Many specimens are eventually discarded due to a lack of collection information.

Wash as much dirt as possible from the roots and pat dry before pressing.

If flowers are large enough, cut one or two open and press flat so the interior/cross-section can be seen. Do the same for fruits. Turn over at least one leaf so the underside will be visible in the final mounting.

Date: 03/31/03	Collector:	Andrea Williams		Collection #: AW-03-03	
Binomial:	*Allium triquetrum*	Authority:	L.		
Family:	Liliaceae	Common Name:	threecorner leek		
Distinctive Features: Onion odor, triangular stem, sl succulent, bracted umbel of 5-15 6-tepalled fls; perianth white with grn midvein					
Habitat:	disturbed areas				
Assoc sp.:	*Rubus discolor, Achillea millefolia*		plus weedy grasses		
Location Description:	Freshwater Lagoon Spit				
Numeric Location:	Orick Quad, T10N R1E S6				
Slope: 0%	Aspect:	N/A	Elevation:	~30 ft	
Comments:	New to list; weedy and a potential problem				

Remember to specify units and give any useful details!

Figure 4.1. Sample collection label

Table 4.1. NPSpecies field descriptions

Data Dictionary Report

File Name: NPSpecies97.mdb
Table Name: tblVouchers

Field Name	Description
ParkCode	4-Character park code (Golden Gate National Recreation Area = GOGA)
LatinName	Accepted scientific name of specimen.
ParkAdminUnit	Administrative Unit for Park (ie. Alcatraz Island, Mori Point)
Sensitivity	Security level: 0=sensitive; 1=park only; 2=NPS only; 3=public
DocLatinName	Documented scientific name of species in the original records when it was observed
Date	Date of observation or collection (mm/dd/yy)
EndDate	Companion to Date; allows date ranges (mm/dd/yy)
Time	Time of observation or collection (24-hour clock, hh:mm)
Observer	Name of observer or collector
ObserverNumber	Field collection number provided by collector, if available.
Habitat	Concise description of habitat where observation or collection was made
Elevation	Estimated elevation in feet or meters where observation or collection was made
ElevationUnits	Units for elevation (feet or meters)
SpecimenID	Repository identification number of voucher specimen.
SpecimenLocation	Acronym, name and address of herbarium, museum or other location of specimen
Location	Concise description of collection site within the park or location from specimen label
LocalLocCode	An optional code for a permanently recognized local location.
Latitude	Latitude in decimal degrees
Longitude	Longitude in decimal degrees
UtmX	UTM X coordinate (northing)
UtmY	UTM Y coordinate (easting)
UtmZone	UTM zone
Datum	DATUM for location (e.g., NAD27, NAD83)
LocationError	Estimated location error in meters. How close are the coordinates to the true location?
DataSource	Source of voucher data (e.g. database name, file name, etc.)
Comments	Comments
FromPark	Collected within park boundary - yes or no.
VoucherType	Specimen, audio recording, image, or other.
VoucherTypeDetails	Concise description of voucher type.

3.0 Post-Collection Processing

3.1 Identify the Specimen

Do your best to identify the plant to species level; it may be a good idea to confirm this identification by asking a local expert (Vegetation Management Staff as determined) and comparing to an existing herbarium specimen or online photo (http://calphotos.berkeley.edu/flora/).

3.2 Determine Whether You Will Accession the Specimen

If the specimen meets any of the following criteria, you should consider accessioning it into the herbarium collection; if it does not then you may consider adding it to a field collection (an informal notebook or set of specimens that can be used in the field for reference) or you may discard it once you are finished identifying it for whatever purpose you had.

Is the species under-represented (less than 5 specimens) in the herbarium?

Does specimen display a unique feature?

Is this a unique voucher associated with a study or monitoring project?

Is the specimen exceptional in some other way?

Is there complete collection information associated with the specimen? Plants that lack location, habitat, collector and/or identifier information should not be accessioned.

3.3 Independent Verification

If plants will be verified, do not accession until they are returned. This makes loan paperwork unnecessary. A receipt for property is sufficient.

Whether or not to verify: If the specimen is to be formally accessioned, independent verification of the specimen's identity should be considered when one or more of the following conditions are met:

There are no pre-existing specimens of the same species in the collection;

The collection represents a new species to the park;

Designated park staff are unable to confirm its identification with certainty;

The specimen is otherwise unique or problematic.

Where to get them verified: If independent verification is desired for a quantity of specimens, the herbarium manager or curator should arrange for a contract through a recognized herbarium; current options include informal assistance from California Academy of Sciences, Margriet Wetherwax at the Jepson Herbarium at UC Berkeley, or the herbarium at UC Davis. Small numbers of purported exotic species may be taken to the local County Agriculture Commissioner's Office, where the biologist will assist in identification and/or filling out a Pest Damage Record. Independent verification can pose a problem, because many herbaria want to keep specimens or duplicate specimens after identification, but NPS property guidelines will only allow for "permanent loans" which may not suffice in the eyes of some herbaria. Be sure to discuss with local or regional NPS curation staff who have experience with natural resource collections (Carola DeRooy at Point Reyes, or Diane Nicholson at Oakland Regional Office), before sending out specimens.

Documenting and packing specimens for shipping: Include proper documentation including a spreadsheet listing the specimens with collection numbers. Place a label with each specimen. See Figure 4.2 below for an example of a label that can be used.

Dry and press, but do not mount them. This facilitates identification.

Place them in folded, numbered sheets of newsprint, occasionally layered between cardboard, and tie the entire bundle with string to facilitate removal from the box.

Pack the box tightly to prevent anything from moving around within it.

Send it via a reputable carrier (FedEx, UPS, USPS), insured. If feasible, hand carry.

Date Collector Collection # Binomial Authority Family Common name Please do not make notations in this space, as these labels will not be included with the specimens once cataloged. You can make additional notations on the reverse of this temporary label, or on separate archival paper, with the collection number noted.	Please make all of your notations anywhere in this space. This portion will be cut off and affixed to the actual herbarium sheet, with the official label. Det: Margriet Wetherwax Date:

Figure 4.2. Temporary label to be attached to specimens sent off for verification.

3.4 Accessioning the Specimen into the Formal Herbarium Collection

A collection of dried plants to be added to the parks' herbarium needs an accession number, as a group, and individual catalog numbers for each specimen. Obtain these from the Museum Curator. Specimens collected as part of a study should be accessioned together, clearly indicating relevant study information. Researchers who have collected specimens under a Scientific Research and Collecting Permit must provide cataloging data in the form specified by the Museum Curator in the permit. Catalogued specimens must be entered into the ANCS+ database. Contact the Herbarium Manager or Museum Curator for procedures and permit requirements if applicable. Remember that in entering the specimen you should be preserving the process as well as the final identification, so original identifications and identifiers should be recorded even if incorrect. Information needed for ANCS+ includes the data from the sheet above, as well as the date of any subsequent identifications and the name of the person identifying (verifying) the specimen.

3.5 Adding the Specimen into NPSpecies

> ***SPECIMENS MUST INCLUDE LOCATION, HABITAT AND COLLECTION DATA TO BE ACCESSIONED AND INCLUDED IN NPSPECIES.***

Currently, some duplication of data exists between park herbaria and NPSpecies. Researchers who have collected specimens under a Scientific Research and Collecting Permit under I&M must also provide data in electronic format suitable for upload into NPSpecies. Updates to the park species list and to NPSpecies need to be accompanied by a voucher specimen and coordinated through an NPSpecies "gatekeeper." The current coordinator for vascular plant data updates is Andrea Williams. She can provide you with the template ("voucher_template.xls") with which you can record your collection information.

3.6 Mounting the Specimen

Once specimens are identified and verified, they may be mounted. Mounting can take place before or after accessioning. Not all pressed material must (or should) be mounted: only the most complete plants, plus additional fertile material or leaf variations, should be adhered to a sheet—enough to show the plant's characteristics, but not so much as to crowd the page. Split into "a" and "b" sheets if necessary, and be sure to leave room for label information. If you are inexperienced at mounting, consult I&M or Vegetation Management staff and/or look into one of the references listed at the end of this document.

4.0 Glossary

Accession number: The number assigned to an object or group of objects to be added to the parks' collection.

Authority: The original publishing author for a scientific name. We use *The Jepson Manual* for our authority style.

Binomial: The genus and species of a scientific name. Taken here in the broad sense to include subspecies.

NPSpecies: The National Park Service catalog for natural resource inventory data.

Phenotypic: The outward expression of genetic; flowers of Scotch broom show phenotypic variation in that some are all yellow and some have red wings.

TRS: Township, Range, Section; the "legal" description of a piece of land. Less specific than UTM (Universal Transverse Mercator) or latitude/longitude in pinpointing a location.

Voucher: A physical representation of a plant observation; the pressed, mounted plant "vouching" that a plant was found in a given location.

5.0 Literature Cited

Bridson, D. and Forman, L., editors. 1992. *The Herbarium Handbook*, rev. ed. Kew, Royal Botanic Gardens.

Regents of the University of California. 1993. *The Jepson Manual: Higher Plants of California* (third printing with corrections, 1996). James C. Hickman, editor. University of California Press. Berkeley, CA. xvii + 1400pp.

United States Department of Agriculture, Agricultural Research Service. 1971. *Preparing Herbarium Specimens of Vascular Plants*. U.S. Government Printing Office. Washington, D.C. vi + 29pp.

Standard Operating Procedure (SOP) 5: Data Management, Analyses, and Reporting. Version 2.1 (May, 2009)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
		Williams, A.	Adapted from Streamflow	SOP is for early detection	1.0
1.0	12/30/08	Williams, A.	Added detail, primarily to trend and synthesis section	In response to review comments	2.0
2.0	5/31/09	Williams, A., T. Phillipi, and A. Forrestel	Added detail, primarily to trend and synthesis section	In response to review comments	2.1

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Appendices

1.0 Overview

Two critical pieces of the SFAN I&M Program are integrating natural resource inventory and monitoring information into National Park Service planning, management, and decision making; and sharing National Park Service accomplishments and information with other natural resource organizations and form partnerships for attaining common goals and objectives. To meet these goals, a detailed management plan is needed to ensure data quality, interpretability, security, longevity and availability. The invasive species early detection protocol is a status-based, rapid-turnaround program. Each survey has the potential to record information vital to immediate management needs, but is also necessary for long-term models of invasive species occurrences. Additionally, having a number and variety of different parks and partners sharing data, and including data collected by volunteers, makes a detailed data management plan critical.

2.0 Scope and Applicability

The procedures below cover routine data management activities for the SFAN invasive species early detection monitoring program. This Standard Operating Procedure describes how the SFAN invasive species early detection monitoring protocol meets data management objectives through data entry specifications, database design, quality assurance and control measures, metadata development, data maintenance, data storage and archiving, and data distribution. Data management procedures are explained for all the components of the protocol, including field data collection, data downloads, data processing and analysis, map requirements, and reporting specifications.

Data analysis and reporting are essential components to any monitoring protocol. This document outlines analysis methods, reporting timelines and materials, as well as the four basic uses of the data: the immediate reporting of location to management; the periodic analysis of trends in species distribution and abundance; the correlation of invasive species populations with other data (habitat, disturbance, date, etc.); and the periodic analysis of data for protocol improvement.

3.0 Description of Data Files and Database

3.1 GeoWeed Database

GeoWeed is a data management application created by Sonoma Ecology Center (SEC) for logging and tracking weed infestations and management efforts. The application evolved from TNC's Weed Information Managment System (WIMS). Some of the changes made to the WIMS database design are described below. The database is NAWMA-compliant. GeoWeed uses the ESRI ArcPad application on a handheld computer in the field to map and describe plant patch occurrences, assessments of patch size and density, as well details of treatments such as mechanical, chemical, and revegatation. This digital data collected in the field is uploaded to a desktop Microsoft Access database where data is managed, reports can be generated, and shapefiles are created.

Some of the advantages to this data management system are:
- Digital data collection and uploading saves time over manual data entry
- Streamlined Access database interface for users who are not database literate
- Simplified single-click map shapefile creation allows maps to be created "on the fly"

Figure 5.1. GeoWeed installed on handheld units

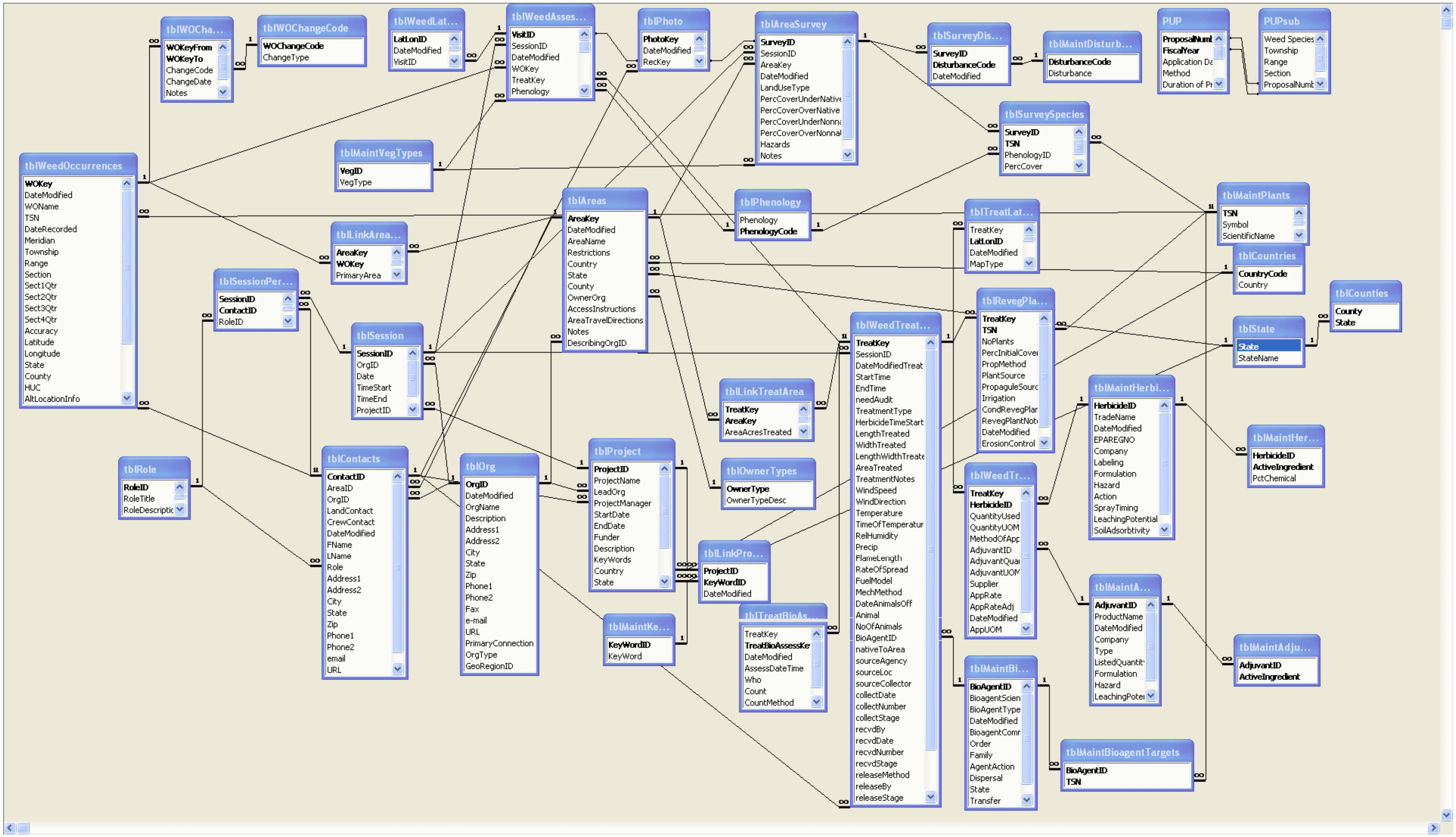


Figure 5.2. Table relationships in GeoWeed.

GeoWeed was created based on needed improvements to WIMS. As of this writing, the database is still undergoing revisions and improvement and may have additional iterations over the next year, which will be reflected in future revisions of this SOP. Current improvements include:

- Referential integrity, improved data structure, and other data-safety measures
- Metadata about organizations and projects, important for sharing data
- Clarification of previously ambiguous data and methods of data collection
- New data elements such as a way to record revegetation efforts and monitor vegetation community change over time
- Ability to record negative data for multiple species and confidence levels for identifications
- In-record photo viewing and storage

Future planned upgrades, depending on availability of funding, include:

- Tools for data review and quality-checking
- Instant, "on-board" map displays requiring no additional software
- Additional refinements in the way data is collected and managed
- Exports for automatically sharing data with live map services and alert systems

The user manual for GeoWeed is in [Natural Resources]:\Habitat Restoration Team\Geoweed\usermanual\geoweed33_userguide_0709.zip, but the following series of figures and captions should serve to orient the reader to the basics of the database. Command buttons and code-driven text boxes are used to navigate to forms, add data records, locate and edit data records, and query the data. Where possible, default values are set and combo boxes with fixed values are used to reduce data entry errors. For example, all plant name fields are set as combo boxes which link to the look-up table tblMaintPlants, which uses scientific names and TSN's to prevent misspellings. The user interface includes the following key features:

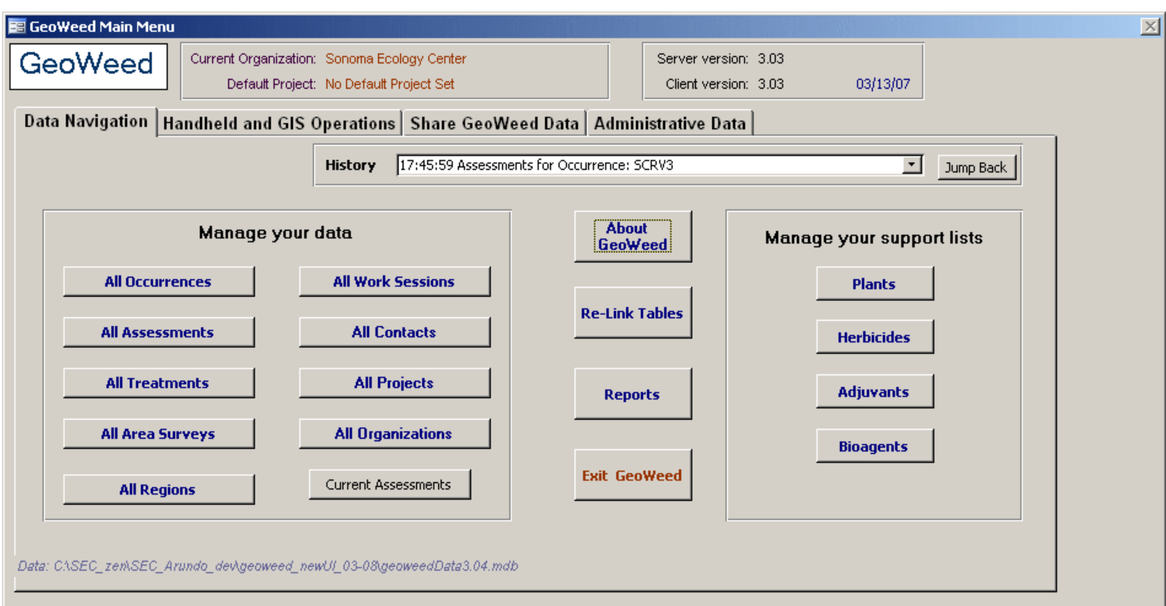


Figure 5.3. Database switchboard—main screen of the user interface, viewed at startup.

The conceptual basis of GeoWeed, carried over from WIMS, lies in the initial point *occurrence* of a species, representing the center of an infestation, tied to a series of polygon *assessments* and *treatments* over time. Additional items involve tracking work through *sessions*; individuals, organizations, and projects (including metadata information) through *contacts, organizations*, and *projects*; negative data and plot-based species data through area *surveys*.

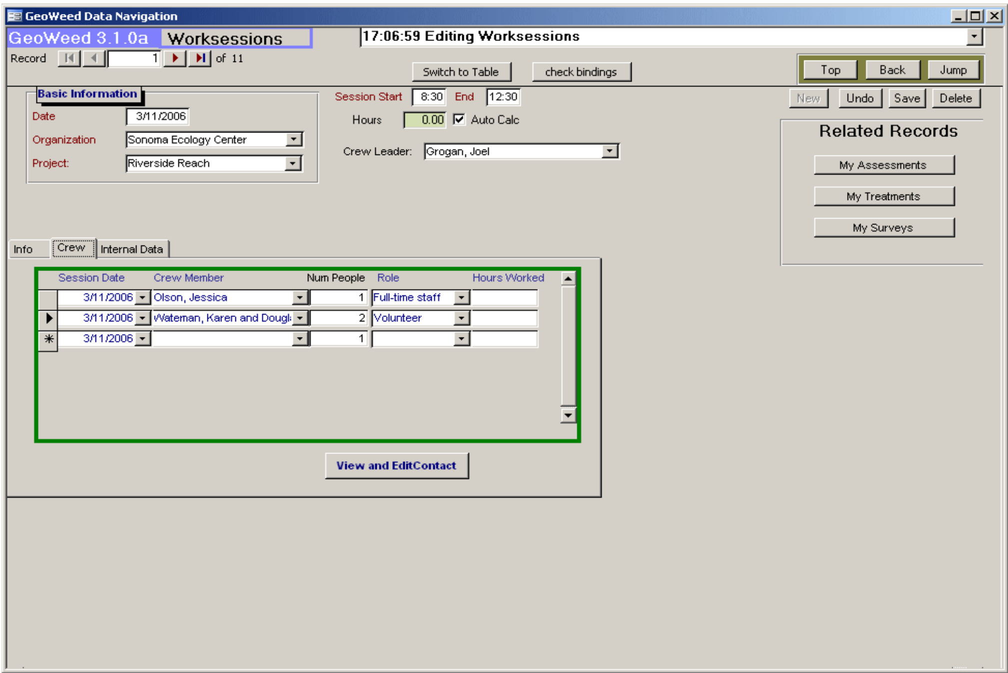


Figure 5.4. Session form to record work effort and type (e.g., staff, volunteer, contractor).

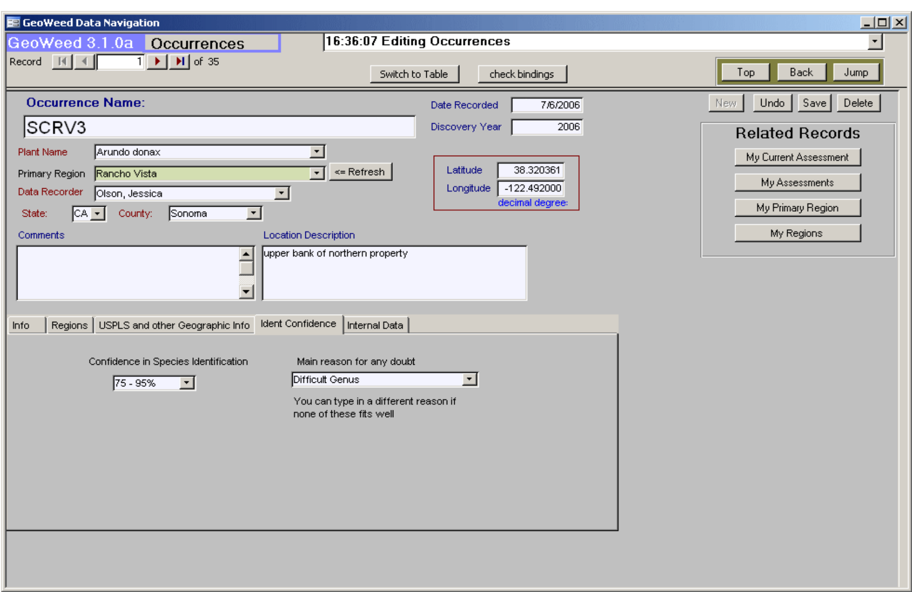


Figure 9. Occurrence form to record species (including confidence in identification) and location.

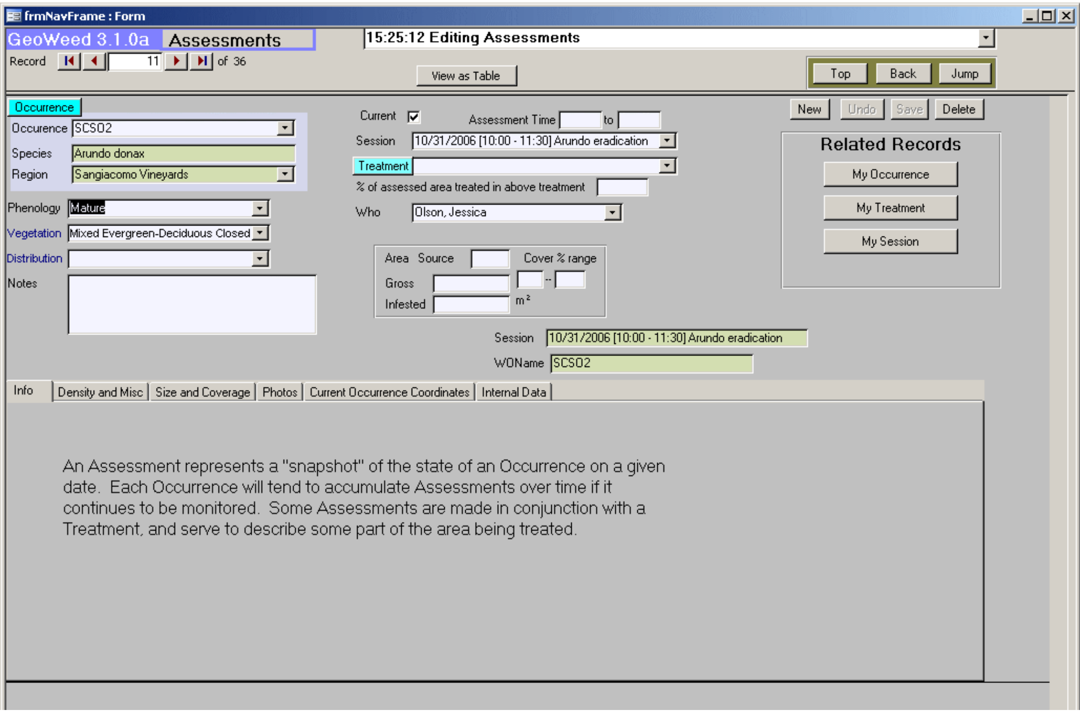
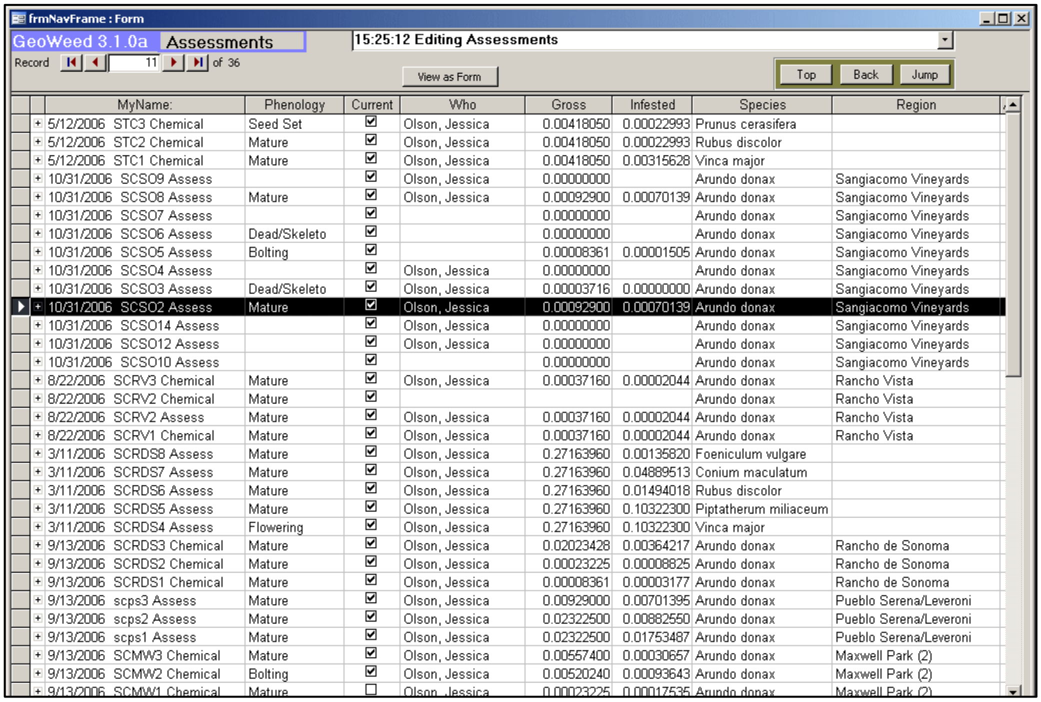


Figure 10. Assessment form to record gross and infested area, phenology and distribution of species, associated vegetation, and photo data. Multiple assessments may be tied to a single occurrence point to track the population over time.



MyName:	Phenology	Current	Who	Gross	Infested	Species	Region
5/12/2006 STC3 Chemical	Seed Set	☑	Olson, Jessica	0.00418050	0.00022993	Prunus cerasifera	
5/12/2006 STC2 Chemical	Mature	☑	Olson, Jessica	0.00418050	0.00022993	Rubus discolor	
5/12/2006 STC1 Chemical	Mature	☑	Olson, Jessica	0.00418050	0.00315628	Vinca major	
10/31/2006 SCSO9 Assess		☑	Olson, Jessica	0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO8 Assess	Mature	☑	Olson, Jessica	0.00092900	0.00070139	Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO7 Assess		☑		0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO6 Assess	Dead/Skeleto	☑		0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO5 Assess	Bolting	☑		0.00008361	0.00001505	Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO4 Assess		☑	Olson, Jessica	0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO3 Assess	Dead/Skeleto	☑	Olson, Jessica	0.00003716	0.00000000	Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO2 Assess	Mature	☑	Olson, Jessica	0.00092900	0.00070139	Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO14 Assess		☑	Olson, Jessica	0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO12 Assess		☑	Olson, Jessica	0.00000000		Arundo donax	Sangiacomo Vineyards
10/31/2006 SCSO10 Assess		☑		0.00000000		Arundo donax	Sangiacomo Vineyards
8/22/2006 SCRV3 Chemical	Mature	☑	Olson, Jessica	0.00037160	0.00002044	Arundo donax	Rancho Vista
8/22/2006 SCRV2 Chemical	Mature	☑				Arundo donax	Rancho Vista
8/22/2006 SCRV2 Assess	Mature	☑	Olson, Jessica	0.00037160	0.00002044	Arundo donax	Rancho Vista
8/22/2006 SCRV1 Chemical	Mature	☑	Olson, Jessica	0.00037160	0.00002044	Arundo donax	Rancho Vista
3/11/2006 SCRDS8 Assess	Mature	☑	Olson, Jessica	0.27163960	0.00135820	Foeniculum vulgare	
3/11/2006 SCRDS7 Assess	Mature	☑	Olson, Jessica	0.27163960	0.04889513	Conium maculatum	
3/11/2006 SCRDS6 Assess	Mature	☑	Olson, Jessica	0.27163960	0.01494018	Rubus discolor	
3/11/2006 SCRDS5 Assess	Mature	☑	Olson, Jessica	0.27163960	0.10322300	Piptatherum miliaceum	
3/11/2006 SCRDS4 Assess	Flowering	☑	Olson, Jessica	0.27163960	0.10322300	Vinca major	
9/13/2006 SCRDS3 Chemical	Mature	☑	Olson, Jessica	0.02023428	0.00364217	Arundo donax	Rancho de Sonoma
9/13/2006 SCRDS2 Chemical	Mature	☑	Olson, Jessica	0.00023225	0.00008825	Arundo donax	Rancho de Sonoma
9/13/2006 SCRDS1 Chemical	Mature	☑	Olson, Jessica	0.00008361	0.00003177	Arundo donax	Rancho de Sonoma
9/13/2006 scps3 Assess	Mature	☑	Olson, Jessica	0.00929000	0.00701395	Arundo donax	Pueblo Serena/Leveroni
9/13/2006 scps2 Assess	Mature	☑	Olson, Jessica	0.02322500	0.00882550	Arundo donax	Pueblo Serena/Leveroni
9/13/2006 scps1 Assess	Mature	☑	Olson, Jessica	0.02322500	0.01753487	Arundo donax	Pueblo Serena/Leveroni
9/13/2006 SCMW3 Chemical	Mature	☑	Olson, Jessica	0.00557400	0.00030657	Arundo donax	Maxwell Park (2)
9/13/2006 SCMW2 Chemical	Bolting	☑	Olson, Jessica	0.00520240	0.00093643	Arundo donax	Maxwell Park (2)
9/13/2006 SCMW1 Chemical	Mature	☐	Olson, Jessica	0.00023225	0.00017535	Arundo donax	Maxwell Park (2)

Figure 11. Assessments may also be viewed in table format to see progression over time.

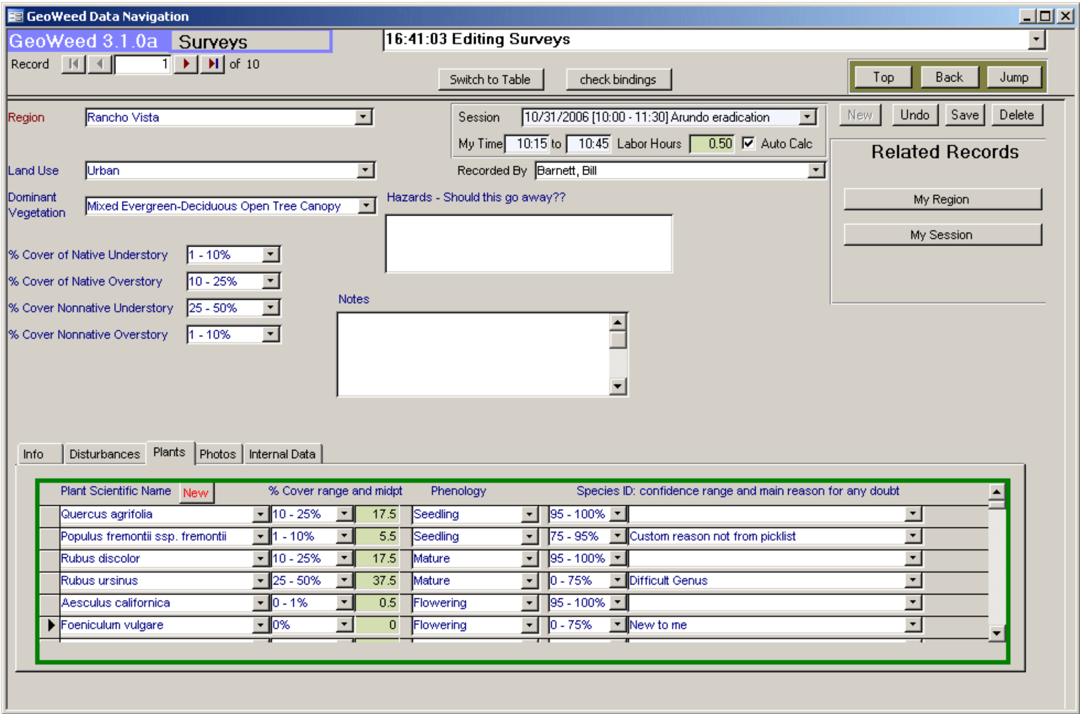


Figure 12. Survey form can track negative data, function as an inventory, or capture monitoring data.

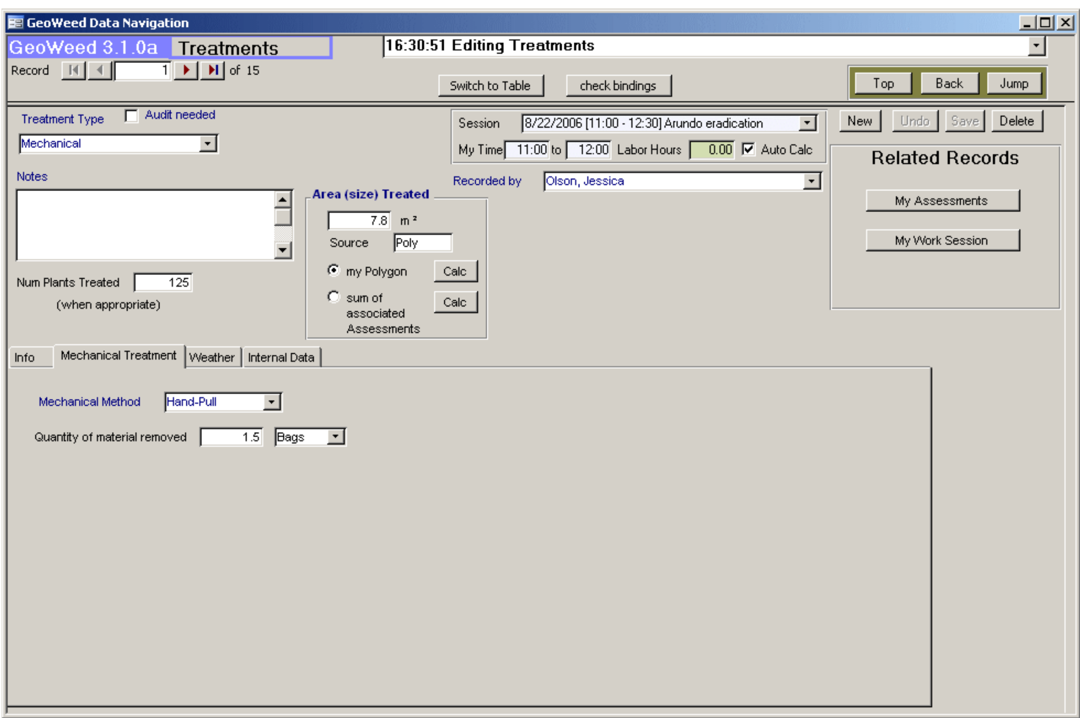


Figure 5.9. Treatment form can track treatments associated with assessments. Park staff can enter their rapid response treatment of early detections here. Digital photos taken in the field can be linked to surveys or assessments.

3.2 Data Entry, Verification and Editing

Digital data collection is accompanied by paper data sheet (see SOP 3) backup to assist with verification and prevent total loss of survey data through equipment failure. Data downloads into the desktop database are recommended after every field day, at a minimum after a field week. This allows the surveyor to see any obvious errors and prevents data loss from battery failure or system corruption. Monthly checks of downloaded and entered data against paper data sheets help ensure the completeness and accuracy of data. All data sheets have a field for date and initials for data entry and verification. The database annotates when records have been changed. Future planned "on-board" instant map displays will also allow the surveyor to check collected points for accuracy. This should help immediately assess the accuracy of points, which may be poor due to environmental conditions, the ability of the data recorder, or the type of GPS unit used.

3.2.1 Data Entry

The actual process of data entry, data work flow, and data upload are all covered in the GeoWeed User Manual, as well as in training presentations in the Slideshows folder of the GeoWeed database. However, overviews of common tasks are presented as appendices.

3.2.2 Data Verification and Review

Additional verifications will be made by the Project Manager through re-survey (soon enough to prevent identification confusion due to phenological changes) of one of ten surveys; if errors are found, a re-survey of a second area is recommended; if no errors are found, re-survey one of every 20 surveys. Using duplicate, trained observers during a survey also increases confidence in data collected. Both "hot" and "cold" expert checks are recommended, where survey data are checked with the observer or through another survey, checking data collected during the original survey (see Forest Inventory Analysis Program Appendix 21, USDA 2005).

Data validation is the final step in assuring the accuracy of data transfer from raw to digital form. Questionable data are identified, reviewed, and corrected if necessary. Automatic validation procedures that check the data as it is entered are built into GeoWeed and will be modified, as needed, to improve error checking abilities. These automatic validations are programming elements that "censor" the data based on known ranges. Examples of common errors are missed decimal places, numerical data placed in the wrong field or out of accepted or expected limits (*e.g.*, latitude and longitude outside of California).

At the end of each calendar year, monitoring staff are responsible for reviewing mapping data accrued during the year by all staff mapping invasive plant species at the parks. This review consists of:

- Assembling all information provided through invasive species work.
- Reviewing maps for completeness; maps without sufficient means of relocating the site must be deleted.
- Sorting information by type: paper maps; and coordinates, GPS data, or shapefiles.
- Comparing paper maps to existing GIS layers. Maps that show known populations and provide no new information will be discarded. Maps that provide new discoveries will be digitized into existing shapefiles.

- Reviewing coordinates, GPS data, or shapefiles; deleting data that does not show new information and filling in NAWMA-standard fields; adding new data to existing shapefiles. Every effort will be made to incorporate all information into GeoWeed.

3.3 Database Rollup and Data Exchange

Maintaining separate databases while providing for data sharing introduces unique data management challenges. Each site database must have its own manager to ensure data quality in preparation for data exchanges, make backups based on the frequency of data entry, and trouble-shoot for that database's users. PORE and PINN will only have one database each, and JOMU will not maintain a separate database, but unless an online portal solution can be found, GOGA will have at least three databases: one for I&M and Marin Headlands staff, one for Presidio staff, and one for GGNPC staff. An additional database may be necessary for Site Stewardship. Monthly data exhanges are recommended: a "first Friday" data harvest by the Natural Resource Specialist of site databases into a master database with data from all parks, followed by creation of backup copies after data exchange. Previous versions of the data file will be archived using the Archive button in GeoWeed and kept for six months, with one copy permanently archived at the end of each year. Archived versions are automatically named by date of archive (*e.g.*, GeoWeedData-GOGA_current-2008_12_15_12_16_39.zip is the GOGA data file of GeoWeed archived on December 15, 2008).

3.4 Metadata Procedures

Data are collected year-round for invasive species, and data collection is never "finished." The NPS GIS Committee recently required all NPS GIS data layers be described with the NPS Metadata Profile, which combines the FDGC standard, elements of the ESRI metadata profile, the Biological Data Profile, and NPS-specific elements. Although no standard has been applied to natural resource databases and spreadsheets, the SFAN will complete the NPS Metadata Profile to the greatest extent possible to document databases and spreadsheets developed for the SFAN I&M program, but actual data will not be posted as described below.

Metadata in compliance with current NPS standards will be posted to the NR-GIS Datastore for the GeoWeed database by the invasive species early detection Program Manager in coordination with the SFAN Data Manager. The metadata record for GeoWeed will initially be developed in Dataset Catalog v3.0, an MS Access metadata development and catalog tool developed by the NPS I&M Program. Dataset Catalog is currently the preferred tool to begin metadata records for MS Access databases because of its ability to harvest entity and attribute information from this database format.

The metadata record for GeoWeed will be exported from Dataset Catalog as an XML file and completed in NPS Metadata Tools and Editor v1.0 (NPS MTE), thus allowing for all NPS-specific elements in the metadata record to be completed. Because invasive species tracking is a continuous data set, only metadata records and not the actual data products will be posted to the NPS Data Store. Contact information within the metadata record will direct interested parties to the Project Manager for further inquiries. The metadata record posted to the NPS Data Store will be updated annually in December after the early detection data has been error-checked and seasonal staff are gone for the year. Versioning and updates to the GeoWeed database will be largely done through Sonoma Ecology Center, who will number and document changes and releases.

Spatial data products associated with this protocol will be associated with annual reports, which will be catalogued in NatureBib, the NPS's on-line natural resource bibliographic database. The location data for this project is stored as coordinates within the GeoWeed database. Because GIS spatial data layers are generated from the database, only simplified metadata records will be developed for data layers contributed to the parks' annual invasive species layer using ArcCatalog and the NPS MTE. The metadata records will be saved as XML files and should be stored with the spatial data files.

3.5 Data Archival Procedures

Electronic files will be maintained in the Network Inventory & Monitoring directory on the Marin Headlands (Inpgogamahe1.nps.doi.net\Divisions) server at the Golden Gate National Recreation Area, under \Shared\Vegetation\Invasive Plants. The Dell PE 4600 Marin Headlands server has several built-in redundancy features to ensure data are kept safe, including a pair of hard drives configured as Level-1 RAID (mirroring), data storage on a Level-5 RAID with data capacity of 200GB, and redundant power supply. A SDLT 110/220 GB tape drive is also connected to backup data. A full nightly backup is done on every Tuesday and Friday. The remaining days of the week, including Saturday and Sunday, are incremental and are appended to the same tape that is used for full backup. The last tape of the month is taken offsite to further protect the data. GOGA IT team members are responsible for managing the tape backup jobs and tapes. The SFAN maintains an archive directory on the Marin Headlands server where a copy of GeoWeed will be archived annually. The working copy of GeoWeed is on the Marin Headlands server, but in the \Natural Resources\Habitat Restoration Team\Geoweed folder, so more staff (GOGA and I&M) can access it.

Table 5.1. Where major electronic files are kept within the Invasive Plants folder.

File Type	Folder	Subfolder
Protocol	SFAN Protocol	Review Documents
Citeable Literature	Reference Material	
Species Lists	Species	Species lists
Priority Species ID cards	Species	ID cards\final_copies
Weed Watcher Materials (datasheets, maps, trainings)	weedwatchers	
Subwatershed Prioritization	Databases	Prioritization

Paper data sheets and annotated maps will be kept in the I&M office for three years, then archived in park archives with reference copies kept in the office. After annual map review, compiled spatial electronic data will be archived on the parks' GIS servers in consultation with the park GIS Specialist.

Data collected on volunteers that includes personally identifiable information (name, contact information) must be safeguarded in accordance with the Privacy Act of 1974 (5 USC 552a); contact information for volunteers should not be entered into the GeoWeed database but kept on the volunteer agreement and, if necessary, kept in a password-protected separate database or spreadsheet (VIPStats_weedwatchers.xls) accessible by the Project Manager and Technician.

Paper forms should be kept in a locked cabinet. Terminated agreements should be shredded to prevent disclosure of personally identifiable information.

4.0 Data Analyses & Reporting

Data acquired from surveys may be time sensitive. Acting upon new detections of highly invasive species is critical, therefore a feedback loop between monitoring and treatment programs must be established. On a monthly basis, new detection monitoring reports will be submitted to the local park weed manager. These reports will include both newly discovered species and newly discovered infestations. On an annual basis, the natural resource specialist will summarize the data, review methods, make program adjustments as necessary. Every five years, data will be analyzed for patterns of invasion and subwatershed priority ranking. Additional reporting mechanisms are summarized in Table 5.1.

4.1 Potential Issues with Analyses

By collecting varying levels of data on a large suite of species using a number of different observers, analysis requires first acknowledging potential issues that may arise, and choosing the appropriate summary method or subset of collected data. While some issues—such as the accuracy of data points—may be addressed through quality control, others require careful parsing to return realistic answers to the questions we pose. We must also remember that the primary purpose of this protocol is to find new populations of priority invasive species and give that information to park managers; information on spread rates and landscape infested will be answered using data gained primarily under the Plant Community Change protocol.

Only a small subset of invasive species populations have both a point and polygon collected under this protocol; therefore, for infested area data, only the List 1 species information may be reliably tallied for trends over time for a single infestation. Given the potential error of most GPS units used by staff—approximately three meters in open habitats—and the use of cover-class midpoints for infested area calculations, the amount of time before an increase in infested area may be reliably assumed could be over five years, if we posit an expansion rate of 0.5 meters per year and an annual 10% increase of cover; the increase in calculated infested area is largely driven by shifts from one cover class to the next (and therefore one midpoint to the next), rather than actual cover or gross area changes. During the years between initial measurement and when actual change exceeds potential measurement error, the population should already be eradicated or undergoing treatment, which will confound remeasurements. Furthermore, while small List 2 species populations also have polygon data collected, one cannot reliably sum the area to measure landscape-level area infested for List 2 species as the large infestations do not have infested area recorded. Similar to the remeasurement conundrum for List 1 species, in several years the population should either be undergoing treatment, or it may have grown larger (greater than 100 m^2 gross area) than to merit remapping under this protocol.

Point data are more widely collected than polygon data under this protocol, but even then not collected for all priority species. List 1 and 2 species populations will always merit a point, but large List 3 populations do not. Also, other data collectors may be collecting occurrence points using a different protocol—*e.g.*, collecting a point for each tree for Presidio historic Monterey cypress forest mapping, rather than one point for the entire stand. This makes using the total number of points alone a potentially unreliable measure of change. An additional potential source of error is the placement of the point within a population: occurrence points should be placed near the center of an infestation, so measurements of distance from a landscape feature (*e.g.*, perennial water, or trail) to the occurrence point may be biased away from these features for larger populations.

Detectability is less of an issue for measurements over time. A population should grow more detectable over time, and, once found, be re-found unless it was treated, or searched for at the wrong time of the year. With the detectability index, observers should be able to know if a species, if present, should be visible during their search. Species within certain guilds—trees, shrubs, brooms, and thistles—have similar detectabilities, so guild-based analyses may be appropriate. Others—herbs, forbs, grasses, vines/groundcovers—may vary greatly, so if species are lumped they should be done so on the basis of similar detectabilities over the growing season (see Appendix SOP 3 B for detectability calendar).

Data analyses and reporting purposes also vary under this protocol. Data may be used for monthly reporting, priority list revision, annual reporting, species modeling, or trends over time. Each of these uses are examined in the sections below.

4.2 Monthly Reports

Monthly reports focus on updating managers and interested parties to recent survey efforts and time-sensitive finds; the primary audience is internal and separate reports should be prepared for each park. Monthly reports contain simple information: species found and general area. A sample monthly report is shown in Figure 10. Future reports will have area names linked to mapped occurrences, as well as a “bottom line” feature for easy roll-up to the annual report containing number of trail miles surveyed and approximate survey area; staff and volunteer hours for the month; number of occurrences and assessments mapped.

What *SNOO* in the Park?

Golden Gate Weed Watchers
Invasive Species Early Detection
Significant New Observations and Occurrences
March 2008

> **Importance of Early Detection of Invasive Species**
> Aggressive non-native plants threaten to change the landscape of our national parks. These plants can alter entire ecosystems, reducing habitat for the unique plants and animals of the San Francisco Bay Area in the very places set aside to protect them. Often, by the time a plant is noticed as a problem it has spread throughout an area. The Weed Watchers help patrol the park for some of the newest invaders—and find them when they can still be prevented from becoming a permanent part of the landscape.

March began another year of weed watching, and welcomed three new volunteers to the program at a kick-off training on the 6th in the **Presidio**. In addition to learning the top 12 priority weeds to watch, participants encountered several on their short hike—including a previously unknown patch of **periwinkle** (*Vinca major*) east of the Log Cabin. Other species of note included **English holly** (*Ilex aquifolium*) and a couple patches of **capeweed** (*Arctotheca calendula*).

The following Thursday, a brief training hike rambled through **Subwatershed 7-2** from **Fort Cronkhite** Building 1063, past the Native Plant Nursery, to Building T1111, and back along Bunker Road. The patch of **periwinkle** by the nursery steps was finally mapped, as were the few new **thoroughwort** (*Ageratina adenophora*) plants in the ditch by T1111.

On the First Day of Spring, March 20th, Weed Watchers preceded a big day of Big Year events at Muir Woods with a hike up the **Subwatershed 12-3** portion of the **Dipsea Trail** from Muir Woods Road to the Deer Park Fire Road. While no priority invaders were seen, someone had dropped **periwinkle** flowers along the trail. Andrea was concerned about the reproductive **English ivy** (*Hedera helix*) and **bird cherry** (*Prunus avium*) seen near the top of the rise, as well as the **ornamental plum** (*Prunus cerasifera*) spreading in the Monument and seen along the trails.

Want more information? Contact Andrea Williams, Natural Resource Specialist, at 415-331-0639 or Andrea_Williams@nps.gov

Figure 10. A sample Monthly report. Future reports should have bold placenames linked to early detection maps and be posted to the intranet.

4.3 Annual Reports

Annual reports focus on summarizing the survey year; the primary audience is internal, but in contrast to monthly reports only one report will be prepared network-wide. Local and regional collaborators may also request the report. Suggested content for the annual report is as follows:

TITLE PAGE

TABLE OF CONTENTS PAGE(S)

EXECUTIVE SUMMARY PAGE (abstract)

1.0 INTRODUCTION
- 1.1 Background (may be distilled from this protocol and repeated without change)
- 1.2 Objectives

2.0 METHODS
- 2.1 Search areas
- 2.2 Field methods (reference protocol/SOP)
- 2.3 Training(s)
- 2.4 Analyses/GIS manipulations
- 2.5 Species list revisions (if necessary)

3.0 RESULTS
- 3.1 Numbers of miles surveyed, persons and hours (by park)
- 3.2 Number of occurrences and list by scientific name (by park)
- 3.3 Total area covered by each List 1 species (by park)
- 3.4 Maps by priority species and area
- 3.5 Outreach: number of downloads from website; number of trainings, presentations, new and existing volunteers; other accomplishments
- 3.6 Species list revisions (if necessary)
- 3.7 Detected populations treated

4.0 DISCUSSION
- 4.1 Collaboration
- 4.2 Management recommendations

5.0 LITERATURE CITED

6.0 GLOSSARY

Since the data collected are simple, few calculations are needed before annual summarizing and reporting. A check against collected data and with local land managers, online databases, and park staff annually or as needed will drive revisions to priority species lists. As additional quality and estimation checks, comparisons between projected and actual rapid response, and projected and actual survey miles, can be run. The annual report will be reviewed internally and the format follows the Natural Resource Technical Report (NRTR) series described by the NPS Natural

Resource Publications Management (NRPM; see http://nature.nps.gov/publications/NRPM/). The 2007 annual report may be found at http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/docs/2007%20Annual%20Report%20final.pdf

4.4 Trend and Synthesis Reports

Every five years, a trend and synthesis report will be produced. This report will include trend information by species and location, synthesis of invasive species data with habitat and management information, as well as analyses to improve and refine the program, such as an update to the matrix to refine the list of priority subwatersheds and species and examinations of revisit schedules.

Trends in number of occurrences and species seen, as well as search effort, may be compiled. Trends in sightings for individual species will be of primary significance to management, showing either a species is spreading so rapidly as to warrant increased control efforts or not spreading in wildlands and possibly less invasive than previously thought; similarly, trends in number of sightings by area would show invasion hotspots or areas relatively immune to invasion. These trends are easily produced and displayed in chart format. As controls on the number of occurrences being artificially high from alternate mapping protocols, points and polygons of single species should be buffered by 10 meters and merged to a single polygon if overlapping. Alternately, one could present only data collected under the Inventory & Monitoring protocol; however, that would likely greatly underrepresent the number of actual occurrences. Trends in number of species by subwatershed should not be sensitive to overcollection of occurrences, but one should check if correction for total area (*i.e.*, number of species per acre, due to the variation in subwatershed size) is necessary, and examine if presenting by subwatershed priority may be appropriate.

The synthesis of invasive species data with habitat and management information will help address the third monitoring objective by suggesting factors leading to new invasions along roads and trails; providing data to refine subwatershed rankings for search priority and timing; and helping to identify possible management actions to prevent new infestations. Suggested methods follow.

Analysis of number of occurrences will determine whether detections are increasing, decreasing, or remaining the same overall and for each individual species. Specifically, we will use a generalized linear mixed model with Poisson counts of the number of new detections as our response variable. The basic model we will use is

$$\eta_i = \beta_0 + \beta_{km}x_{ikm} + \beta_{year}x_{iyear}$$

with the link function:

$$\lambda i = E[y_i] = e^{\eta i}$$

$$L(\beta_0, \beta_{km}, \beta_{year}) = \Pi((e^{-\lambda i}\, \lambda i^{\, yi}) / y_i!)$$

Where:

y_i is the number of new occurrences of an invasive species each year

β_0 is the intercept
β_{km} is the number of kilometers of trail searched (this is an offset term, constrained to equal 1)
β_{year} is the year

We will test the following null hypothesis:
H_0: $\beta_{year} = 0$ (the number of new detections each year does not change over time)
H_A: $\beta_{year} \neq 0$

We will run this analysis for all species pooled and separately for each List 1 and 2 species. We may also do additional analyses to compare detections between subwatersheds, vegetation communities, etc by adding these terms to the basic model described above. We may also consider additional response variables such as number of untreated detections, area of List 1 species, or presence/absence of species in a subwatershed. The models may also help with improving survey methods or timing (e.g., if observer is a predictive factor; or if a certain species is strongly associated with date).

To prepare information for analysis, export the Weedoccurrences from GeoWeed, add the shapefile to an ArcMap (ArcMap, ArcToolbox, and ArcInfo © ESRI 1995-2008, Redlands, California) document containing the most current rasters or layers for elevation, aspect, slope, vegetation community, roads, trails, surveyed routes, and hydrology. Use the Projection tool to transform Weedoccurrences from GCS_WGS_1984 to NAD 1983_UTM_Zone_10N using NAD_1983_To_ WGS_1984_1, as analysis tools cannot reproject on the fly; rename the file WOccNAD83. Although ArcMap Identity or Intersect tools may be used to add some information (vegetation type, for example) to the WOccNAD83 file, the preferred method is to use Hawth's Intersect Point Tool (Hawth's Analysis Tools Version 3.27 (Beyer 2004) were used for a test analysis, more recent versions are available at http://www.spatialecology.com/htools) to add all variables of interest (vegetation type, elevation, aspect, and slope) at once. This will add columns and the calculated values to the WOccNAD83 file but will not rename the file as ArcToolbox does. To calculate distance from occurrence points to the remaining factors of interest, use the ArcToolbox Near tool. Import the resulting .dbf file(s) into the analysis database, which also has guild and detectability tables loaded. Use a Microsoft Access database query to build an exportable table with all response variables of interest; import into R (R Development Core Team 2006) for analysis. Make sure you replace all missing data with NA and remove or replace spaces in headings and fields with dots before importing; this may be done in Excel as well. Additional data-gathering work will be needed to compare infestations to management actions such as mowing, trail work, staging areas, dump sites, survey routes, and vehicle parking areas. The R Book (Crawley 2007) has extensive directions on importing information into R and modeling therein, as well as representing modeled data.

In addition to any program refinements suggested through modeling, the data may be easily examined to revise revisit schedules and subwatershed priority. If new occurrences are not being found frequently enough, or too infrequently, revisits should be adjusted. New distribution information can also be used to update the current GIS-based analysis for subwatershed priority, with confidence levels for these data.

The trend and synthesis report may also make additional recommendations to revise the protocol and SOPs. The report will be peer reviewed and follows the Natural Resource Report (NRR) series described by the NPS Natural Resource Publications Management (NRPM; see http://nature.nps.gov/publications/NRPM/).

4.5 Program and Protocol Review

Every five years, the Natural Resource Specialist will review with the Vegetation Working Group to review annual and trend reports, peer review comments, and consider changes to the protocol. Substantial changes including budget or staffing will also be discussed with the network's Technical Steering Committee. By this time, data from Plant Community Change plots may be available. With this preliminary information, and information from the synthesis report, the Natural Resource Specialist should also re-examine the protocol objectives' limitation to road- and trail-side surveys.

Matching survey time to priority species phenology is difficult with 20-50 species. More data collection is needed to determine whether multiple, seasonal visits in a single year or annual visits in different seasons over several years are more effective. Data from revisit surveys will be examined for detectability rates—the size of patches of different species before they are detected, and the time of year of maximum detectability for priority species. New Zealand researchers have modeled species behavior and detectability versus control and budget thresholds (Harris *et al.* 2001), but these intervals do not fit accepted models for California—for example, they give an annual return interval for forests but one to nine years for shrubland. Growth rates from revisits to patches which have not been removed will be used with detectability and removal costs to adjust the surveillance model and revisit timing.

4.6 Data and Report Distribution

In order for the invasive species early detection monitoring program to inform park management and to share its information with other organizations and the general public, guidance documents, reports, and data must be easily discoverable and obtainable. The main mechanism for distribution of the invasive species early detection monitoring documents and data will be the internet. The invasive species early detection monitoring protocol, accompanying SOPs, and all annual reports will be made available for download at the SFAN website, on the Invasive Plant Species page (http://www1.nature.nps.gov/im/units/sfan/vital_signs/Invasives/invasives.cfm).

Monthly reports will be posted on the SFAN intranet (http://www1.nrintra.nps.gov/im/units/sfan/monitor/invasives/invasives.cfm) for park audiences, with hyperlinks to accompanying maps on the Weed Watchers page (http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/maps.cfm). As requested by parks, reports may also be posted on individual park intranet pages to increase interest among non-vegetation management staff.

As discussed previously, metadata records for the protocol's data products will be posted for public consumption at the NPS Data Store. For data products not posted, metadata records will direct interested parties to the SFAN lead data manager for further inquiries.

In addition to the NPS Data Store, the NPS I&M Program maintains an on-line natural resource bibliographic database known as NatureBib. NatureBib records will be created for all of the invasive species early detection monitoring documents, including the protocol, annual reports, and any resulting publications. PDF versions of the documents will also be posted for download in NatureBib. The public version of NatureBib is in development by the NPS I&M program.

Outreach and collaboration are essential to this protocol; additional products for non-vegetation staff and the public include presentations and trainings on priority invasive species; lists with photographs of invasive plants found during surveys; and articles for publications such as "Noxious Times," "Cal-IPC News," "Park Science," or "Fremontia." The table below summarizes products, audiences, and preparation schedule.

Table 5.2. Summary of reporting and communication products.

Communication Product	Lead	Audience	Schedule	Summary
Monthly Report	Biological Technician	Park Resource Managers	Monthly	-Document survey activities -Describe current condition of the resources and immediate management needs -Increase communication within the park and network
Annual Report	Natural Resource Specialist	Park Resource Managers; Local Open Space Managers	Annually	-Summarize survey activities -Describe current condition of the resources and general management needs -Document changes in the protocol (especially species lists) -Increase communication within the park and network
Analysis and Synthesis Report	Natural Resource Specialist	Park Resource Managers	3-5 years	-Determine patterns and trends -Discover correlations among resources being monitored, management activities -Analyze/reprioritize species and subwatersheds -Provide context, interpret data for the park within a multi-park, regional, or national context -Recommend changes to management practices
Program and Protocol Reviews	Network Coordinator	Program Lead, Vegetation Working Group, I&M Technical Steering Committee	5 years	-Periodic formal reviews of operations and results -Review of protocol design and product to determine if changes are needed -Part of the quality assurance–peer review process
Executive Briefing	Natural Resource Specialist	Program Managers, Superintendents, Front line interpretation staff	Annually (based on annual report)	-Two-page summary that lists objectives and questions, discusses annual results, and provides a regional context

Communication Product	Lead	Audience	Schedule	Summary
Articles	Natural Resource Specialist	Internal staff, External Weed Managers, or other public	As able (at least 1 per year)	-Based on executive briefing -Message depends on audience type
Vital Sign Report Card	Network Coordinator	Program Managers, Superintendents	3-5 years (based on Analysis and Synthesis Report	-Single-line graphic-based summary that aggregates trend data into an index
Web Site Intranet	Natural Resource Specialist	Park Staff	Monthly or as needed	-Post all completed reports
Web Site Internet	Natural Resource Specialist	Park Staff, General Public	Annually or as needed	-Post all Executive Briefings, Report Cards, Annual Reports, Protocol, updated maps
Park Presentations	Natural Resource Specialist	Park Staff	As able (at least 1 per year)	-Provide a presentation to park staff during senior staff, all employee, or division meetings at each park upon request; presents program, some results
IM Update	Natural Resource Specialist	Park Staff	Monthly	-Short update on vital signs projects; no more than one paragraph
ID Cards	Biological Technician	Internal staff, External Weed Managers, or other public	As needed	-1/3-page double-sided cards to identify priority species -Shows photos, description, habitat, lookalikes -Excellent partnership and outreach tool
Photos	Natural Resource Specialist	For all reports and publication	Continuous	-Publication-quality photos to support all communication products: digital photos must be 300 pixels per inch resolution in a plain or compressed TIF format -Document ongoing work, special incidents, site visits for communication purposes

5.0 Literature Cited

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Appendix SOP 5 A: Exporting data from GeoWeed database to a handheld PDA.

Double click on the Habitat Restoration Team on **'Inpgogamahe1\NaturalResources'** drive under My Computer. Double click on the folders in the following order: **Geoweed**; **!GeoWeed3.3.1_GOGADB**; **GeoWeedRun3.3.3**. If you have installed a Run file on your desktop, use that instead, but make sure the Data file, **GeoweedData3.3-GOGA_current.mdb**, is on the server. If a security warning regarding unknown publishers appears, click 'open;' if one appears about blocking unsafe expressions, click 'cancel.'
You will see the main screen:

1.

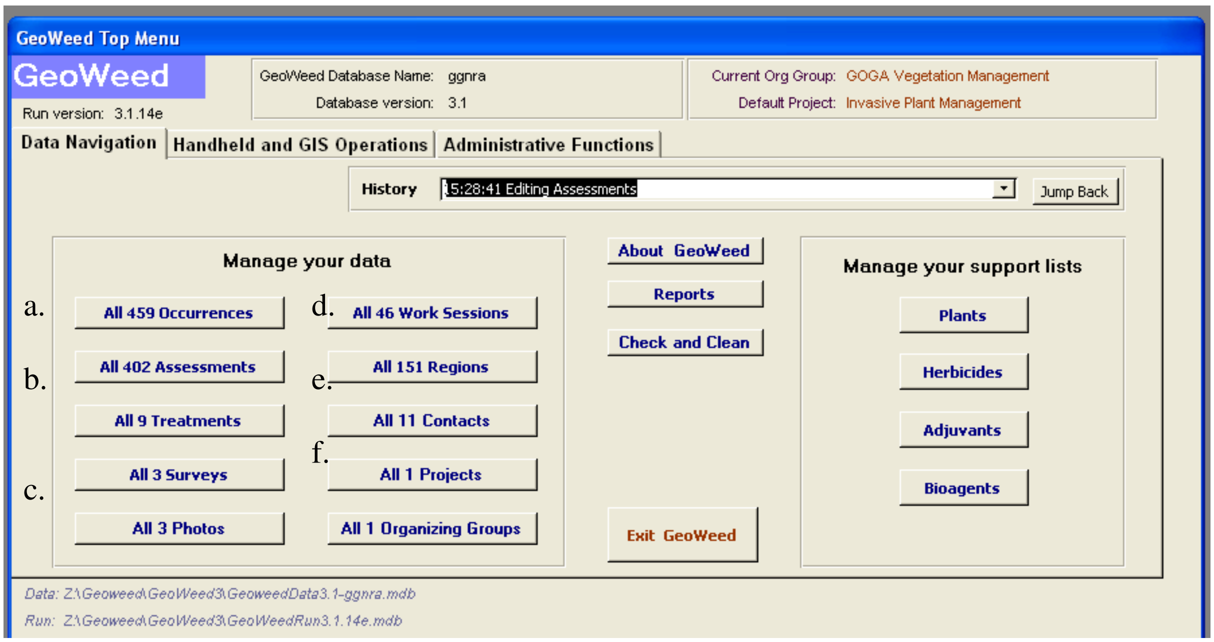

Figure 1. The main menu of GeoWeed with key areas identified (see text).

1. Under Data Navigation tab there are several tabs you will use. Under the "Manage your data" category are included:
   a. Occurrences
   b. Assessments
      - Done for List 1 species (always) and List 2 species (only if <100 m²)
      - There can be multiple Assessments for one particular site, such as one that has been visited repeatedly over a period of time where the size of the vegetation in question has increased/ decreased)
   c. Surveys
      - For Survey 1 (what you saw and # of occurrences) and Survey 2 forms
   d. Work Sessions (entered on return from the field)

Connect the PDA to your computer. Make sure Microsoft ActiveSync is running. The box shows on the screen when the PDA is placed in the cradle and the icon then turns from grey to green. On the Microsoft ActiveSync window click on **Guest partnership**, **Next**, and then minimize it.

In the GeoWeed database, click on the tab for **Handheld and GIS Operations**. Click on the tab for **GIS Export**. On the Introduction, click on **Proceed** (making sure Microsoft Active Sync is running and ArcPad isn't running on the PDA). Select subwatershed(s) in which you will be working. Click on Ctrl to highlight multiple subwatersheds. Click on **Continue**.
For Choose Species, click on **Continue**, which will automatically select all species to take out into the field. For remaining tabs, the default options should remain: under Choose data type, click on **Continue**, making sure that the boxes are checked for Occurrences, Assessments, and Treatments. The circle should also be marked for WGS84 Decimal Degrees. For Data Type Options, click **Continue**, making sure the boxes are left as checked for "ACTIVE Occurrences only, CURRENT Assessment for each Occurrence, and ALL Treatment types." For Choose Date range, leave the Start Date and End Date as is. Click on **Continue**. On the "Go for it?" page, click on the tab for **Create shapefiles**, making sure that the box is checked for "Export shapefiles to my ArcPad handheld PDA." Note the folder shapefiles are also being exported (default is the "Export" folder where your Run file is) in case there are errors exporting directly to the handheld. When asked "Ready to do Export NOW?" click on **Yes**.

Troubleshooting

You should receive a success message and be able to open the files on your handheld. If you receive an error message, attempt the export again but UNCHECK the box for "Export shapefiles to my ArcPad handheld PDA." You can then transfer the files from the export folder to your handheld using ActiveSync. This process is the same as transferring files using Windows Explorer; just Explore your handheld using ActiveSync and copy the files from the Export folder on your Desktop or the server to the GeoWeed folder under Documents and Settings on your handheld.

If the database was unable to create the shapefiles, the Run file may be corrupted. Go to the Top menu, then the Administrative functions tab, and click the Archive GeoWeedData button to make a backup of the data. Then exit the database and delete the Run file. Go up one folder and into the originaldownloaded files; COPY GeoWeedRun3.3.3 and go back to !GeoWeed3.3.1_GOGADB and PASTE it there. Then open the Run file and point it to the Data file on the server.

The problem may also be your computer's communication with the server. You should try to use a Run file on your computer, talking to the Data file on the server. To make your own copy of the Run file, COPY the !GeoWeed3.3.1_GOGADB folder and PASTE it onto your computer somewhere you will remember, preferably on the desktop. Then DELETE the Data file from YOUR copy, open the Run file, and browse it to the Data file on the server. This should solve all your problems. For additional help, call Jen Jordan at 415-331-5023 or Andrea Williams at 415-331-0639.

Appendix SOP 5 B: Creating ArcPad imagery.

Create a file in [I&M]:\Shared\Vegetation\Invasive Plants\weedwatchers\EDsitemapes \arcpad_imagery\2008 (or whatever the current year is) for the trail you will be surveying.

Open ArcMap and browse for maps; open [I&M]:\Shared\Vegetation\Invasive Plants\weedwatchers\EDsitemapes\2008edmaps\edsurveymaps_Base for making maps.

Make sure you are in **Data View**. Find the area you will be surveying. Zoom to 1:5,000 or closer, otherwise you will get an error and export will fail.

Click on the **identify**  button in order to determine which **sid files** you will need to export

This will result in a box popping up.

In the drop down list that is highlighted, select **<All Layers>**

Click somewhere on the map and all the layers should come up in the identify box

Click on the **Get Data for ArcPad7**  button

A box will pop up with instructions

1. Chose which layers you would like to export
    - **GGNRA Trails**
    - **Locator_roads_2003_projected**
    - **GGNRA Subwatersheds**
    - the **sid file(s)** that corresponds with the one identified previously
2. Specify a name for the folder
    - should be named as GGNRA_Subwaterheds found with in the extent of export.

    Ex: **GGNRA_0701_0702_0502**
3. Where do you want this data to be stored?

    Click on the folder to browse to the folder you created at the beginning, which should be located in: Z:\Shared\Vegetation\Invasive Plants\weedwatchers\EDsitemapes\arcpad_imagery\2008

Be patient while this is processing; it could take a few minutes and trying to do other things could result in an incomplete image. After a window appears confirming that the layers are complete, **Pan** to the next area for which you need to create an ArcPad image and follow the above steps. After creating all of the images you will need for the day, you can check them on ArcPad7 on the desktop.

- Navigate to this by opening the **Start Menu**, **All Programs, ArcGIS, ArcPad7, ArcPad 7.0.1 for Windows**
- Add layers you created by using add layers  button; check that they display properly.

Then load the imagery files (in their folders) into the arcpadimagery folder in your handheld's Documents and Settings folder using ActiveSync.

Appendix SOP 5 C. Importing data from the Handheld PDA to GeoWeed database.

1. Make sure Microsoft ActiveSync is running. The box shows on the screen when the PDA is placed in the cradle and the icon then turns from grey to green.
    a. On the Microsoft ActiveSync window click on **Guest partnership**, **Next**, and then minimize it.
2. Open up the GeoWeed Database.
    a. Double click on the Habitat Restoration Team on **'Inpgogamahe1\Natural Resources'** drive. Open **Geoweed\!GeoWeed3.3.1_GOGADB\GeoweedRun3.3.1**. The last folder will have numbers after the 3 in GeoweedRun3 that increase every time a new database version is released.

If a Security Warning "Opening (the letter of the drive) :\Geoweed\!Geoweed3.3.1_GOGADB\GeoWeedRun3.3.3.mdb" appears, click **<u>O</u>pen**.
Click on the **GeoweedData3.3-GOGA_current.mdb** and when it appears in File name box, click **Open**. If you have installed a Run file on your desktop, use that instead, but make sure the Data file, **GeoweedData3.3-GOGA_current.mdb**, is on the server. If a security warning regarding unknown publishers appears, click 'open;' if one appears about blocking unsafe expressions, click 'cancel.'

3. When the GeoWeed Top Menu appears, make sure the GeoWeed Database Name is correct in the top middle box, and the filepaths are correct in the lower left.

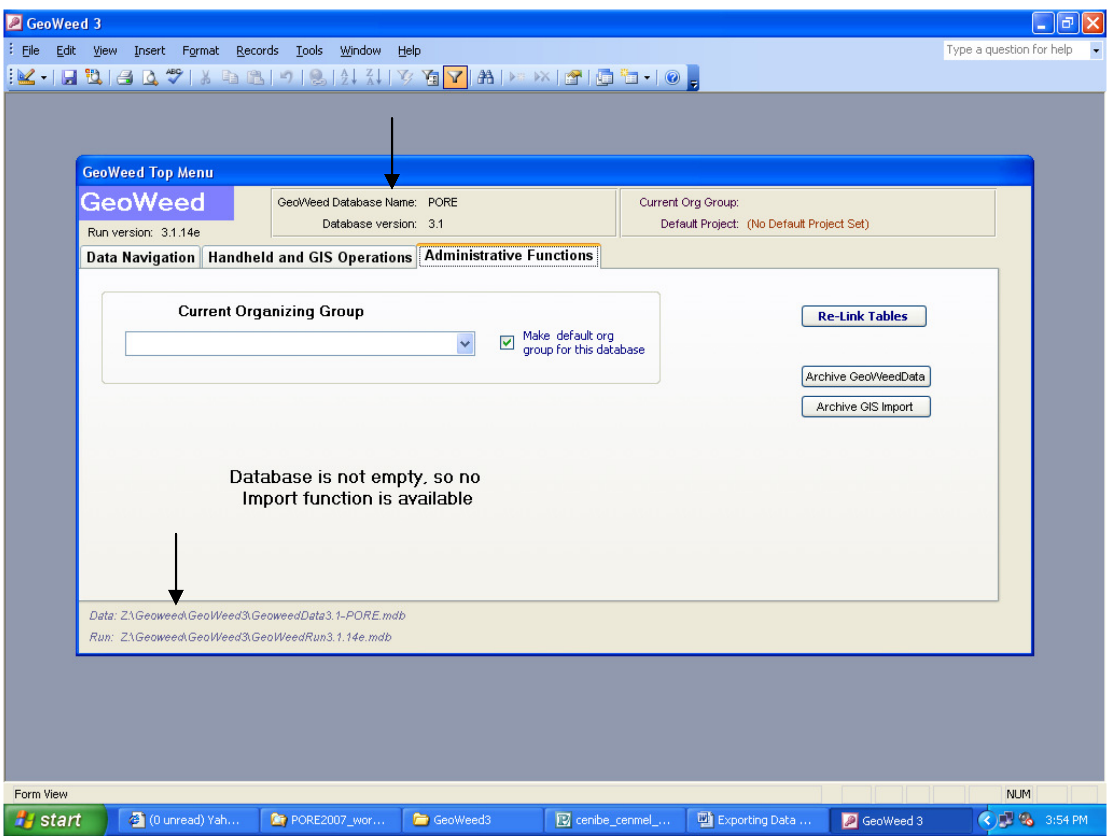

Figure 1. Confirming the database version and location.

4. Unless you have already done so, before importing you must create a Work Session. On the Top Menu, click on **Work Sessions** in the **Manage your data** box.
5. Click on the **New** tab in the upper right corner.

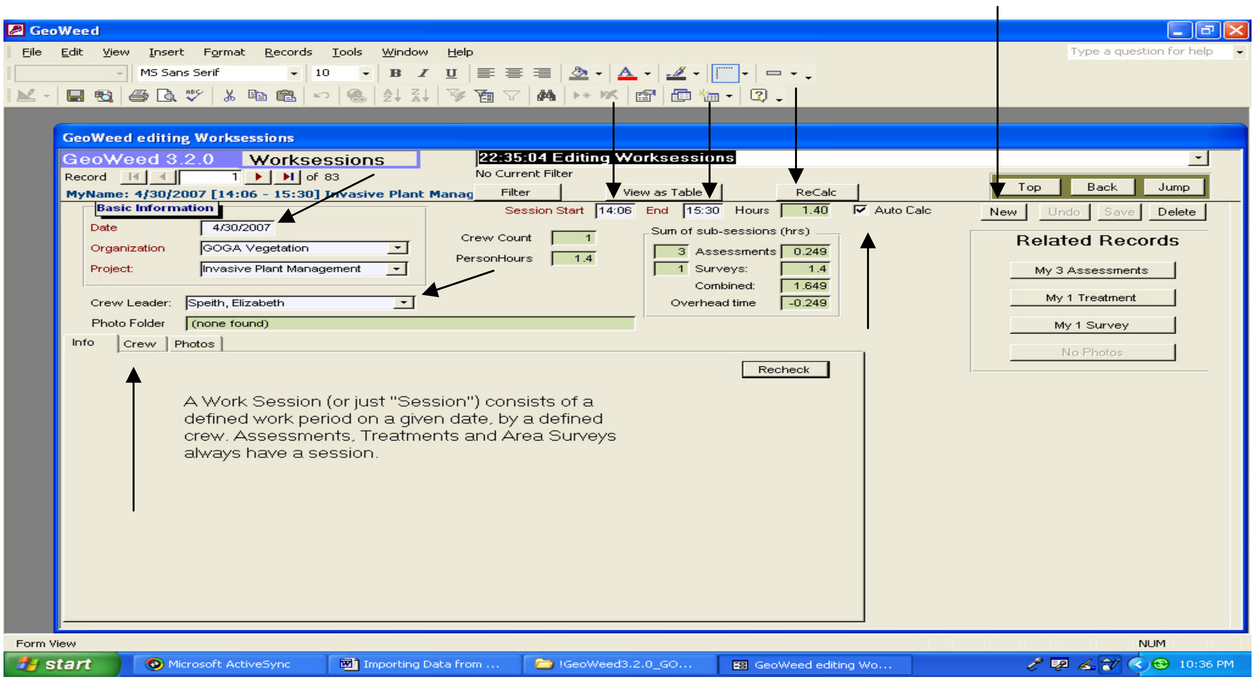

Figure 2. The location of key fields for Worksession entry.

6. On a new, <u>clean</u> page, enter in **Date** (ex: 4/30/2007; not 04/30/07 etc), **Session Start** and **End** (in military time, like 14:00 for 2PM), and **Crew Leader**. Make sure the **Auto Calc** box is checked and if you click on **ReCalc**, the total number of hours in the green box will be determined. Organization should be **San Francisco Bay Area Network** and Project should be **Weed Watchers/I&M Early Detection**.
7. Click on **Crew** tab.

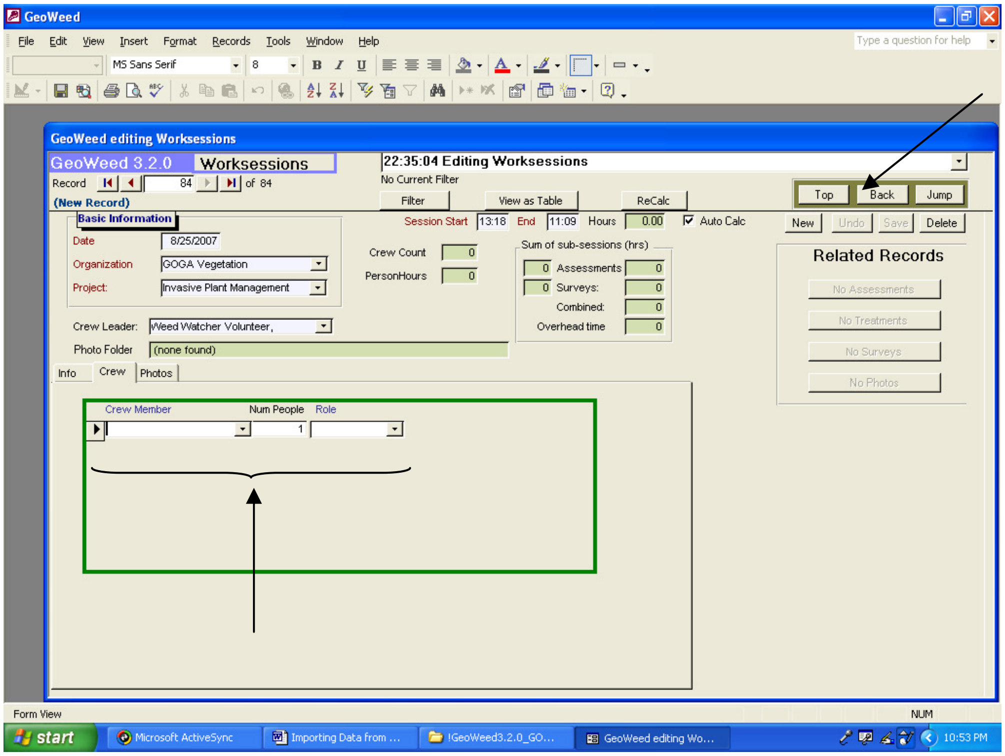

Figure 3. Location of fields for Crew statistics and the Top button.

8. Enter in **Crew Member**, **Num People**, and **Role**. If you're a **Weed Watcher Volunteer** as a Crew Member, then your Role is as **Volunteer**. When finished, click on the **Top** tab to return to GeoWeed Database's home page.

9. Click on the tab for **Handheld and GIS Operations**.

10. Click on the tab for **GIS Import**.

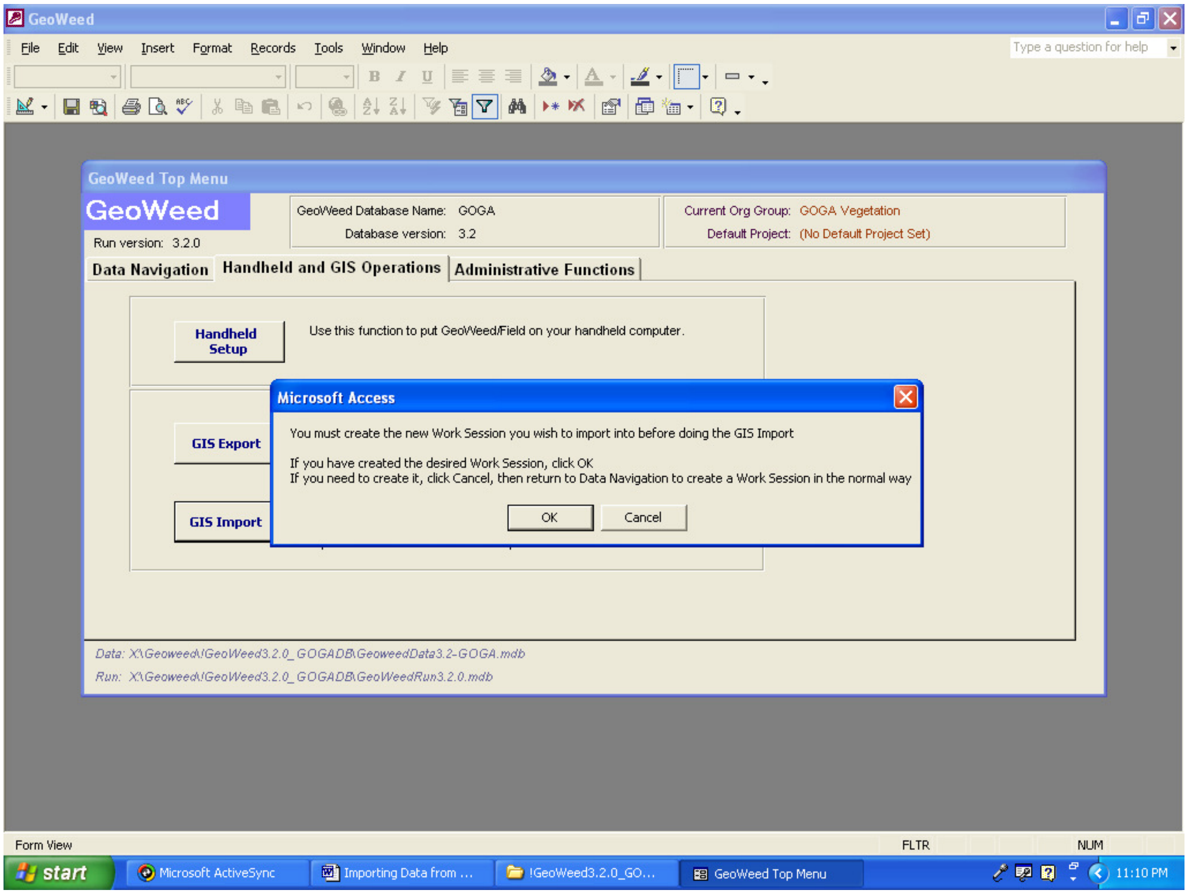

Figure 4. The Worksession confirmation popup in the Handheld and GIS Operations tab.

11. When you see the pop up box above, click on **OK** since you have already created a Work Session.

12. Select **Choose Session** with the appropriate date. Click **Next**.

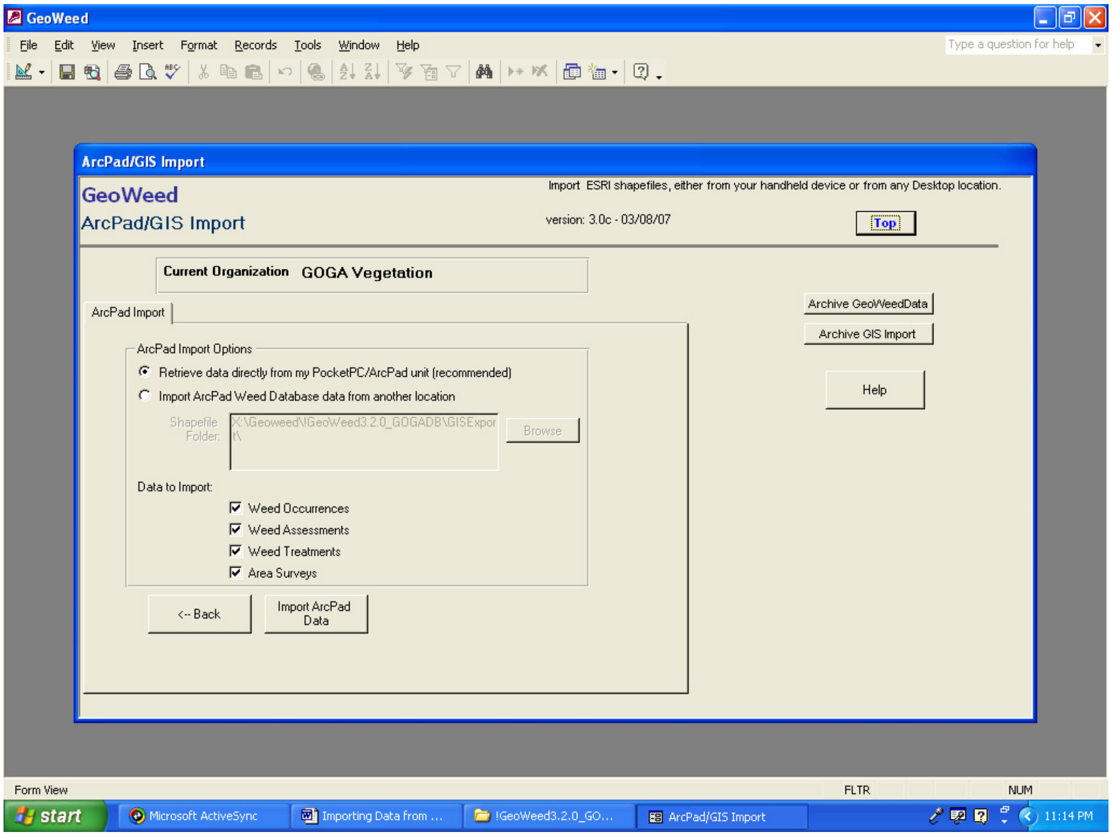

Figure 5. The ArcPad/GIS Import window with data retrieval selections checked.

13. When the ArcPad Import page shows up as seen above, make sure the circle is highlighted for "Retrieve data directly from my Pocket PC…" and that the box is checked for all Data to Import (Weed Occurrences, Assessments, Treatments, and Area Surveys). Click on the **Import ArcPad Data** tab. You should get a success message; if not, check Troubleshooting section of Appendix SOP 5 A.

14. Check imported data against paper data sheets for accuracy and completeness; enter any additional notes or information from sheets and sign off on paper sheets.

Appendix SOP 5 D. Entering and deleting an Occurrence or Assessment.

Entering Occurrences into the GeoWeed Database

1. Click on the **Occurrences** tab under **Manage Your Data** on the "**Top**" or home page of the GeoWeed Database.

2. If you need to confirm that the **Occurrence** has not yet been entered, click on the **Filter** tab, click on the **Dates** tab, entering in the Start and End Date, as well as the **Regions** and **Species** tabs if need be, click on the **Finish** tab, and then the **Use Filter** tab to look at the Records that correspond to the information entered.

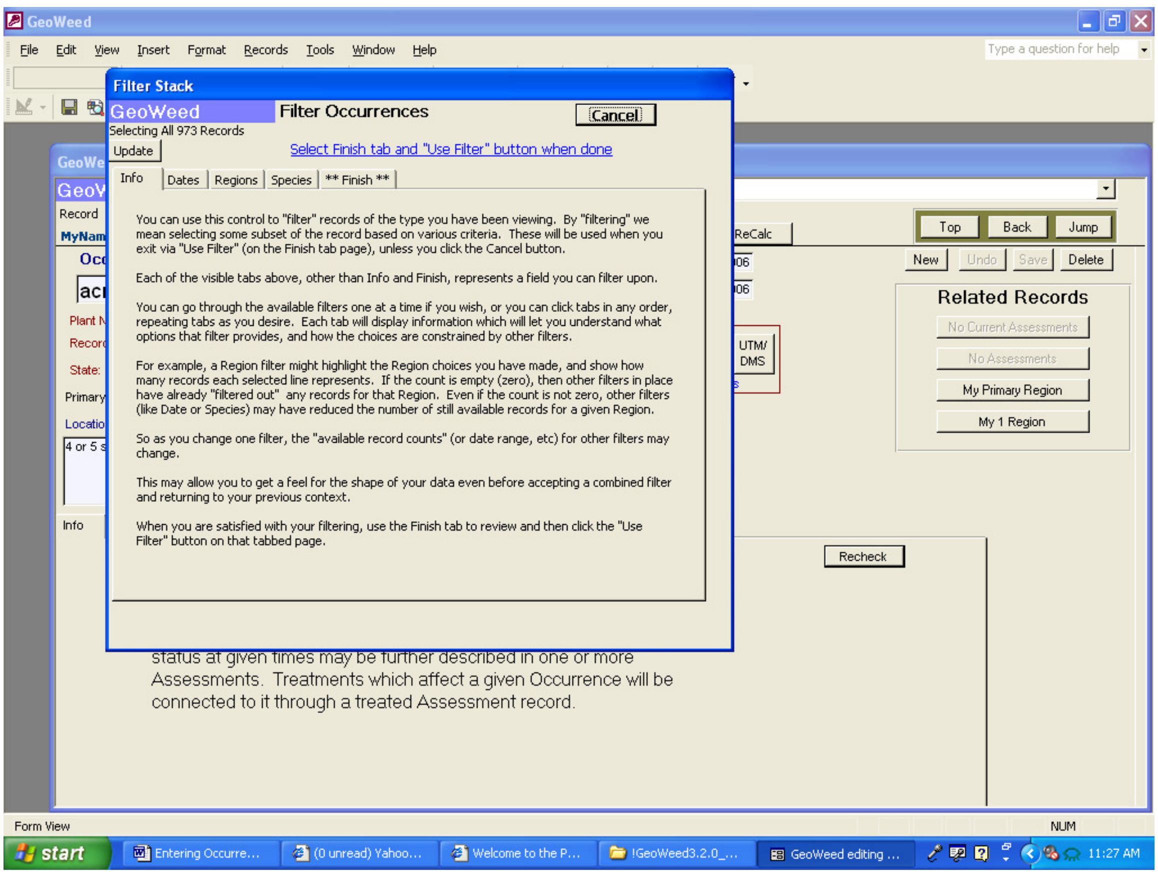

Figure 1. Filtering Occurrences.

3. If the **Occurrence** data has not yet been entered, return to the **Top** (home page), click on the **Occurrence** tab, and click on the **New** tab in the upper right hand corner.

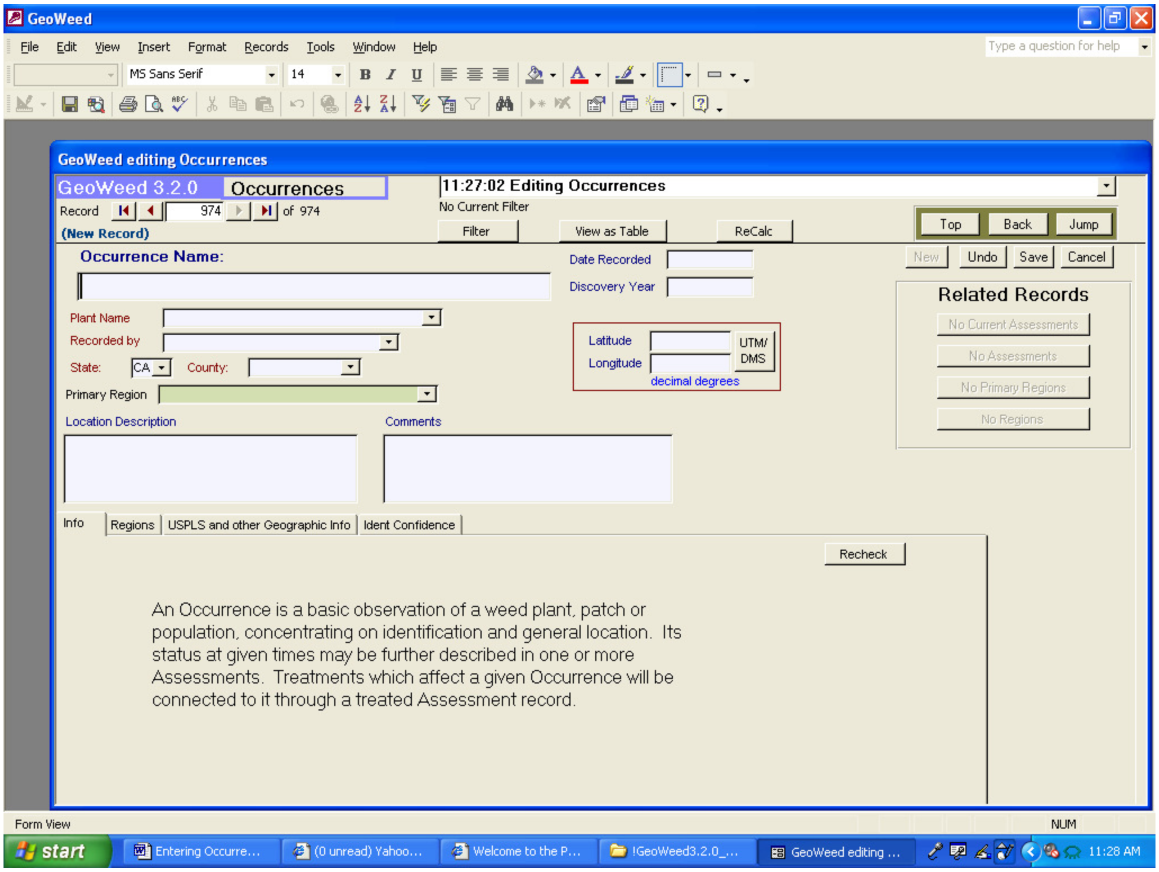

Figure 2. A new, blank Occurrence.

4. Enter the **Occurrence Name** beginning with the Species code (1st 2 letters of the Genus followed by the 1st 2 letters of the species, followed the subsequent 2 numbers (with x's representing 0's) on the USDA Plants Code list. If the plant is not one one of the many lists we have with codes, you can look it up at http://plants.usda.gov/ and search by Common Name, Scientific Name or Symbol (like EUGL to find all the plants linked to that symbol). Species code is followed by the subwatershed (**Region**) in question, and then the year, month, day, and unit #. Unit # relates to which Occurrence is recorded- if this is the third time you've seen *Genista monspessulana* (French broom), its unit # would be 03.

   Occurrence Name example: GEMO2x07032008020303 (for the 3rd time *Genista monspessulana* was observed in subwatershed 7-3 on February 3, 2008).

5. Enter the **Plant Name** (Genus and species), either by typing it in or scrolling down the list.

6. Enter the name of the individual for **Recorded by**, typing it in or scrolling down the list.

7. Enter **Date Recorded** (like 2/3/2008; 0's don't need to be inserted as they are in the dates for **Occurrence Name**).

8. Enter **Latitude** and **Longitude** in Decimal Degrees (not Degrees Minutes Seconds) if that information has been recorded out in the field with a GPS unit. If you need to convert Degrees Minutes Seconds to Decimal Degrees, there should be a button for popup entry of alternative systems; otherwise go to http://vancouver-webpages.com/META/DMS.html.

9. Enter in **Comments** and **Location Description**.

10. Click on the **Regions** tab, entering in the **Region Name** and clicking the box under **Primary Region**.

11. When finished, click on the **Save** tab in the upper right.

Deleting an Occurrence and Assessment

1. First you need to delete an **Assessment**, if one exists for the **Occurrence** in question. Click on the **Assessment** tab on GeoWeed's **Top** (Home) page, followed by the **Filter** tab, typing in the **Start** and **End Dates**, and clicking on the **Regions** and **Species** as appropriate. Click on the **Finish** tab when done, and then the **Use Filter** tab.

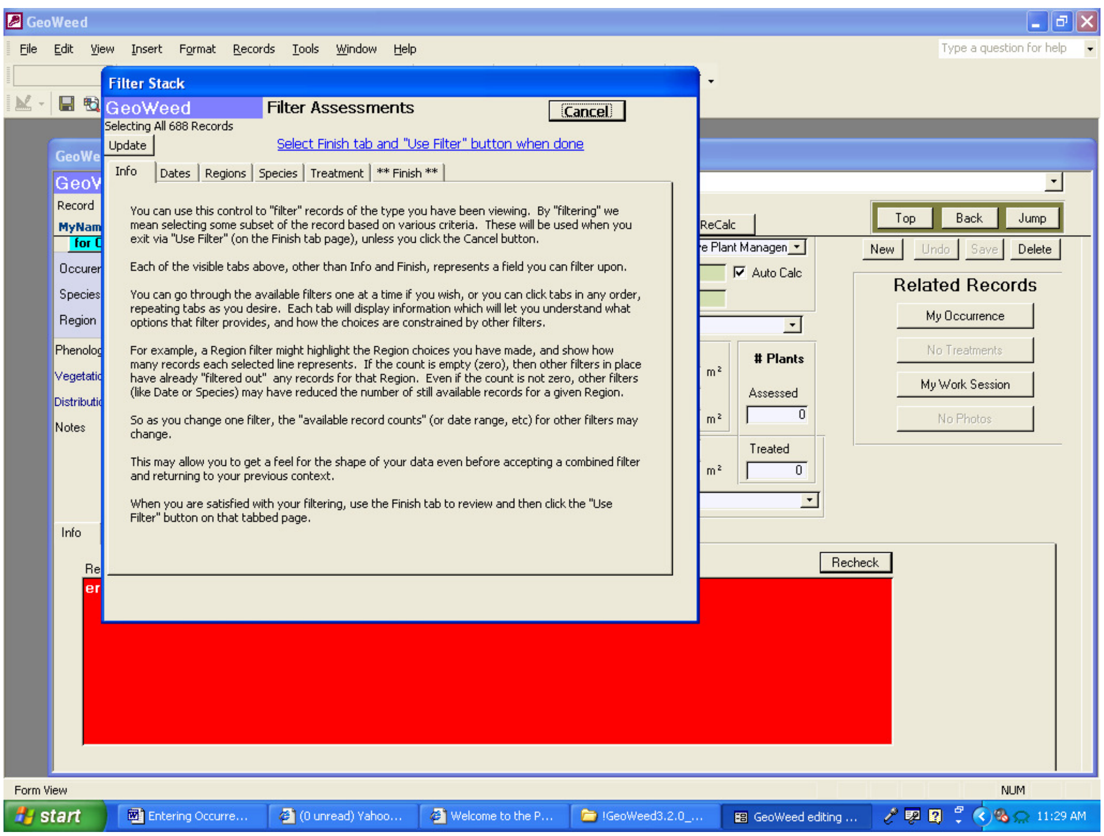

Figure 3. Filtering Assessments.

2. If the **Assessment** has a polygon, delete the coordinate RECORD, not just blank out the coordinates. Under the **Current Assessment Coordinates** tab, select the record by clicking on the section to the left of the record (Figure 4). Then use the **Delete** key. There could be more than one record (if there are more than 15 coordinate pairs), in which case be sure to delete them all. Then you should be able to delete the **Assessment**.

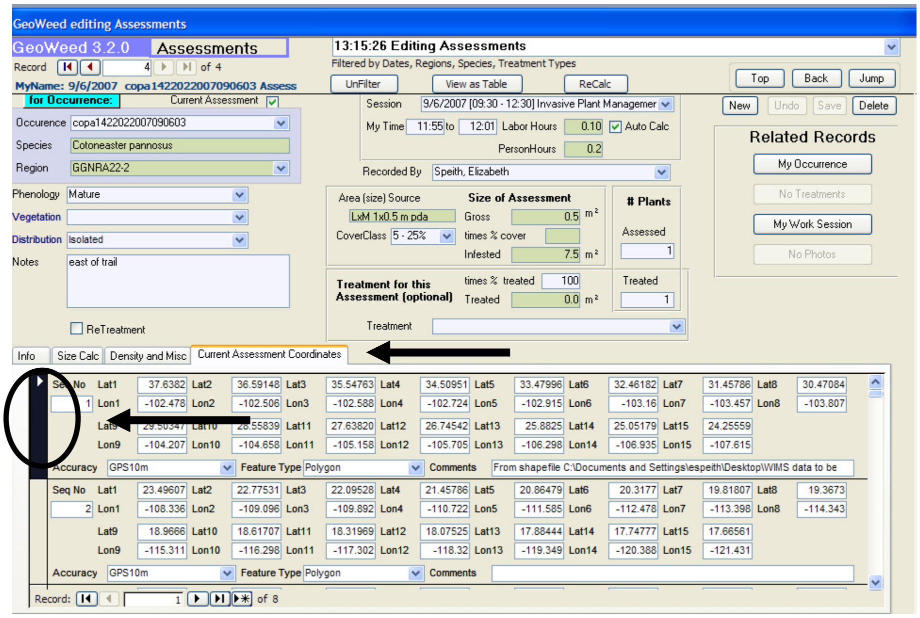

Figure 4: Coordinate rows and delete button

3. When the box below appears, click on **Yes**. You may now delete the Occurrence for this Assessment, if necessary, or delete additional Assessments.

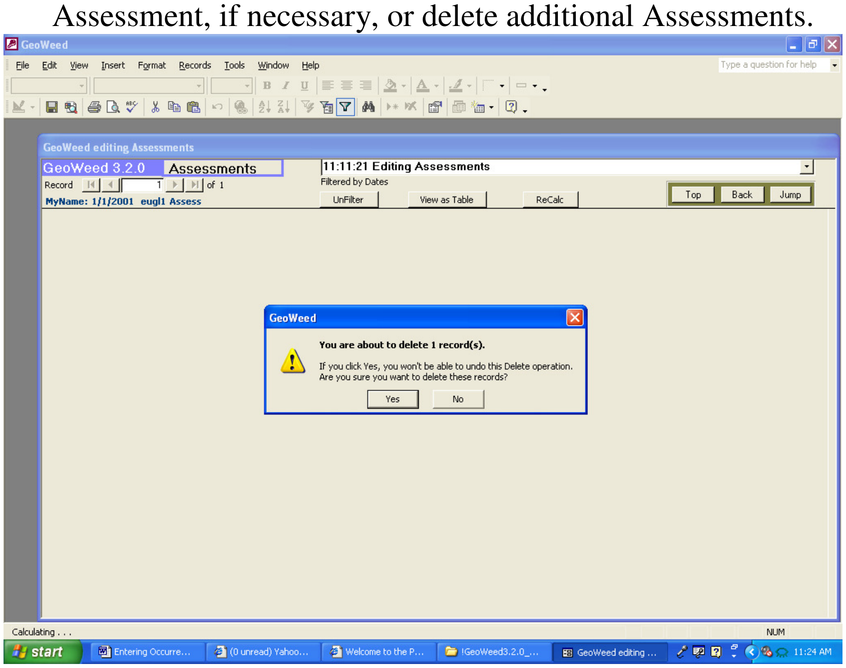

Figure 5. Assessment deletion confirmation window.

4. Click on the **Top** tab to return to the home page. Click on the **Occurrence** tab, **Filter** tab, and enter in the **Start** and **End Dates** in question, as well as clicking on the **Regions** and **Species**, followed by the **Finish** tab. Click on the **Use Filter** tab.

5. When the **Occurrence** appears, first click on the **Regions** tab, followed by the **Delete Link to Area** tab. Click on **Yes** when the Delete box below appears.

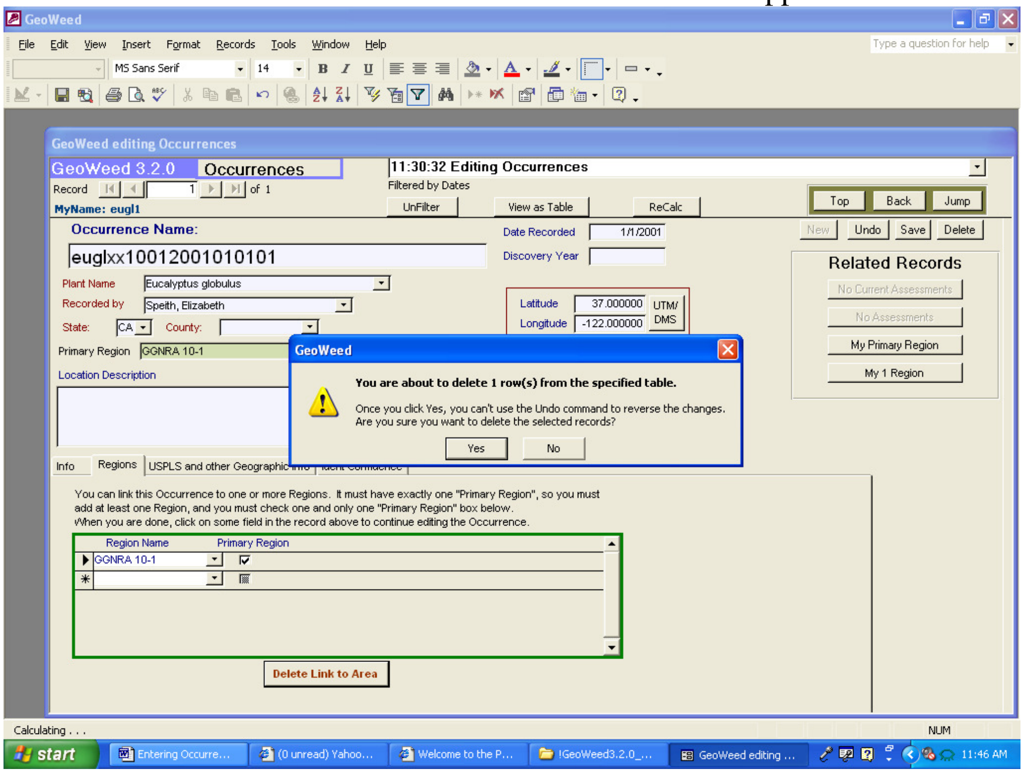

Figure 6. Deleting the Occurrence's link to its Regions.

6. Click on the **Delete** tab in the upper right corner, followed by **Yes** when the Delete box appears. You have deleted the Occurrence, good job!

Standard Operating Procedure (SOP) 6: Volunteer Recruitment. Version 1.1 (May 2008)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	5/1/2007	Speith, E.	Created document.		1.0
1.0	5/8/2008	Williams, A.	Adjusted formatting	Conform to NRTR	1.1

Contents

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Appendices

1.0 Introduction

Volunteer recruitment is an essential element of a successful citizen science program. A successful volunteer recruitment program will yield long-term traditional volunteers such as interns and regular volunteers. The following list contains sources for volunteer recruitment with notes added.

2.0 Online Resources

Remember that personally identifiable data must be safeguarded!
See SOP 5 for more information.

2.1 NPS Websites

The NPS volunteer website (www.volunteer.gov) is available for all volunteer activities that are associated with a NPS program. Appendix SOP 6 A contains an example copy of the information contained on the web page. The Golden Gate NRA contact is Theresa Kreidler (send to theresa_kreidler@nps.gov and george_su@nps.gov). The Point Reyes contact is Chris Lish (415-464-5136, chris_lish@nps.gov).

2.2 Other Websites

CNPS websites

Marin Chapter: http://www.marin.cc.ca.us/cnps/
Yerba Buena Chapter: http://www.cnps-yerbabuena.org
Milo Baker Chapter: http://www.cnpsmb.org/
East Bay CNPS: http://www.ebcnps.org/
The California Native Plant Society (CNPS) provides its members with information regarding both volunteer and internship opportunities.

http://www.cnps.org/forums/
The CNPS Forums email list has a "botany and wildlife jobs" section.

ecolog-l@LISTSERV.UMD.EDU
Sign-up: https://listserv.umd.edu/cgi-bin/wa?A0=ecolog-l&D=0&H=0&O=T&T=1
The Ecological Society of America's email list with grants, jobs, news.

www.idealist.org
Online searchable database of worldwide volunteer opportunities with nonprofits.

www.volunteermatch.org
Online searchable database of volunteer opportunites. Based in the San Francisco Bay Area of California and a frequent partner with the Golden Gate NRA.

www.ser.org/content/job_noticeboards.asp
Society for Ecological Restoration International's career center has to post volunteer and intern positions. Note: This service costs money.

www.sercal.org
California Society for Ecological Restoration's has job listings and volunteer opportunites.

http://career.berkeley.edu/Employers/EmpJob.stm
University of California- Berkeley's career center has a section for internships.

http://career.ccsf.edu/employers/
City College of San Francisco has a career website that has internships.

www.conbio.org/jobs/
Society for Conservation Biology jobs board lists internships and has a wide readership.

ecampusrecruiter.com/marin
College of Marin has career recruitment web page.

http://www.orionsociety.org/pages/ogn/ics.cfm
Orion Grassroots Network internship and Career network has a searchable online database with internship listings. (This Service also costs money).

2.3 Golden Gate Websites

http://www.parksconservancy.org/help/volunteer.asp
Golden Gate National Parks Conservancy's website lists volunteer opportunities in the Golden Gate NRA. Contact Denise Shea (dshea@parksconservancy.org) to add a listing to their website.

3.0 "Word of Mouth" Resources

California Native Plant Society meetings
The CNPS meetings are a good place to meet people who are knowledgeable about plants and who are often willing to volunteer on plant conservation projects.
Marin Chapter: 2nd Monday of the month, January-June and October-November
Milo Baker: 3rd Tuesday of the month
East Bay: 4th Wednesday of the month
Yerba Buena: 1st Thursday of the month

Sierra Club Outings
The Sierra Club outings attract people who enjoy being outdoors and hiking. Sponsoring a Sierra Club Hike and/or attending a hike and recruiting in person can be productive.

University Geography and/or Botany programs
Many universities are looking for guest lecturers and/or internship possibilities for their students. Some programs in the San Francisco Bay area include:
San Francisco State University Institute for Geographic Information Science- Internship with the National Park Service. This program is run by Lynn Fonfa (lynn_fonfa@nps.gov). It is held

every spring (which starts in January) and fall (which starts in August). Requests for participation should be sent to Lynn Fonfa by July and December at the latest.

4.0 Newspapers and print resources

CNPS newsletters
Many of the CNPS chapters print newsletters that reach a large audience.

Appendix SOP 6 A. Sample volunteer position description and volunteer.gov web page.

Location: San Francisco, CA 94123
Start Date: 8/7/2006
End Date: 8/7/2008
Record Date: 8/7/2006

Partner: NPS
Contact: theresa_kreidler@nps.gov 415-561-4755

Activities: • Botany
• Construction/Maintenance
• Computers
• Conservation Education
• Soil/Watershed
• Trail/Campground Maintenance
• Visitor Information
• Natural Resources Planning
• General Assistance
• Weed/Invasive Species Control

Details:

Background

At the Bay Area's doorstep are some of the most beautiful and diverse parklands anywhere. The Golden Gate National Recreation Area is one of the world's largest urban national park systems encompassing 80,000 acres of California coastal landscape visited by 17 million people each year. These parklands add immeasurably to the quality of life in the Bay Area. Our Invasive Species Early Detection Volunteer offers the experience to work in conjunction with the National Park Service, Golden Gate National Parks Conservancy and the Presidio Trust within the GGNRA parkland boundaries.

Working Conditions

Work is mainly performed outdoors in hilly terrain near the Pacific Coast in elevations from sea level to 2000 feet in all extremes of weather. Conditions range from hot dry dusty to foggy damp cold or rainy. There is a frequent exposure to poison oak. Employee may work and operate equipment in adverse conditions that include extended exposure to sun, wind, rain, loud noise, uneven terrain, mud, poison oak, and various invertebrates.

Introduction

The Invasive Species Early Detection Volunteer will work on the GGNRA invasive species early detection program in conjunction the San Francisco Bay Area Inventory & Monitoring Division of the National Parks Service. This program provides ongoing monitoring along trails and roadsides of GGNRA where new weed invasions often occur. Discovering weeds before they become well-established is critical to reducing damage to ecosystem integrity, preventing the loss of habitat for rare plants and animals, and preventing costly natural resource management.

Description of Duties

- Participate in invasive plant identification and data collection training.
- Assist park staff in trail and roadside invasive plant monitoring and mapping.
- Conduct 3 hours of surveys on GGNRA trails monthly over period of six months
- Follow guidelines in making safety a priority; responsible for use of personal protective gear and insuring that all tools, equipment, vehicles and other co-workers are working safely in all related conditions.
- Ability to follow instructions from all park staff, understand and respect all park regulations and policies. Proudly wear the NPS volunteer uniform during working hours.

Knowledge/Skills Desired

- Knowledge of San Francisco Bay region flora, and/or willingness to learn.
- Knowledge of Global Positioning System (GPS) devices and/or willingness to learn.
- The ability to work with a diverse community of people alongside with park personnel.
- Desire and ability to work outdoors, at times in inclement weather and terrain as well as sometimes exert strenuous physical activity while walking.

Benefits

- Training in park staff procedures and policies and knowledge of resources.
- Valuable training in general botany, invasive species, and Global Positioning System (GPS) units and their use in conservation and resource management.
- Opportunities to enjoy the scenery, wildlife and cultural resources of this spectacular park.
- Become a stewardship leader in your community.

Requirements

- Enjoy working with a diverse community of people.
- At minimum, a 6 month commitment.
- A J-1 visa is required for all international (non-resident) volunteers.
- A completed volunteer application form.
- Work in a safe and efficient manner.
- Work as a part of a team and respect co-workers.

click here for details

Suitability: Adults
Difficulty: Strenuous
Link: http://www.ENTER_IM_URL.gov

Appendix SOP B. Getting people to help.

Adapted from material written by the AFSCME Union's Education Department

1. **How do I get people to do a job?**

   Ask them. Few people will volunteer their services. This does not mean that they don't want to be active, however. People wait to be asked. Asking builds activity.

2. **Who should ask them?**

   If possible, someone they **know and trust**; someone whose influence they respond to; a friend, a neighbor, a worker in the same department, a person with prestige in the park. But if you cannot arrange for someone else, do it yourself. Remember that the **act of asking** is itself important.

   After this has been done, be sure that the new recruit is **welcomed** by the leader of the group she will work with. The most effective combination is therefore being asked by someone she already knows and **being welcomed** by whomever is heading up the activity.

3. **What do I tell them?**

   - Make clear what job you are asking them to do, and be sure it has a **definite beginning and end**. People do not want to sign up for life, so do not get them to over-commit themselves.
   - Ask people to do things **they can do well**, especially in the beginning. People are more willing to begin things they know they can do. Later, when they are really a part of your group, they will be more willing to try new things.
   - Tell each person how her job **fits in with the rest**. People want to understand things that they are part of, and they work best when they know that others are depending on them.
   - Let each person know that **her help** is needed. If she feels that you are just "looking for people" she will also feel easily replacable and less responsible for doing a job.
   - Discuss **their own goals** and how they fit into those of the program. People have their own reason for volunteering, and you need to know them in order to lead effectively. Also, you must help people keep their expectations realistic; otherwise you will not be able to meet them.
   - Ask what **they** would like to know, and give them plenty of time and help in raising questions. Many people are reluctant to ask questions, but they will work better after they have done so.
   - Do these things in **person**; do not rely only on emails, postings, letters and phone calls. There is no substitute for talking face-to-face. It lets the person know that you consider the discussion important, and it gives you a chance to get acquainted with her.

- You have a right to be **enthusiastic** about the importance of your work. Do not apologize or belittle it. Your mood will get across to the people you talk to, and they will respond to it.

4. **How do I build an active program?**
    - **Keep Records**. You cannot keep it all in your head. Have a list of members, with names and up-to-date contact information. Keep minutes or notes on jobs to do and decisions made. Keep a list of each person's skills and "strong suits."
    - **Keep your group together**. Have trainings or meetings regularly; do not just keep in touch with each person separately. People need to see and feel that they are part of something big, not just hear about it from you. Call each person before a meeting to make sure she will be there, and knows you care that she comes. Let members share in deciding what jobs to do, how they can best be done, and who can do them best. They know some things that you do not, and they will work harder for things they decide on themselves.
5. **How can I keep people motivated?**
    - **Set high standards of activity**. Members will take their cue from you. And remember, you won't get more than you ask for.
    - For each activity, get **agreement on group goals**. Achieving them will give you a real feeling of accomplishment. Where there are no challenging goals members feel that activity is unimportant.
    - **Get enough people to do the job**. Overworked volunteers stop volunteering, and besides, the extra lift of the group really begins when you have at least 7 or 8 people involved.
    - Be sure each member **knows her job**, and position in the group. It is not enough for you to know, ask her and listen to make sure she knows, too.
    - **Do things at meetings/trainings**. Make decisions; review past work; plan new things, share reported sightings and possible new watch-list species, and infestations removed. People will be more committed to things that have been agreed on in the group. They will feel on record with the others, and see they are part of a productive group. Besides, they won't keep coming to meetings unless they accomplish something.
    - Encourage people to **help each other out** on jobs. "Every woman for herself" is not good committee work.
    - **Pay attention** to people who do not meet standards and expectations. If you ignore their failure, other members will follow them.
    - Recognize good work, and reward it. What you can do will depend on the local situation, of course, but you can always commend good workers at meetings, express your appreciation in person and write letters of thanks.

Appendix A. List of Non-Native Species at SFAN Parks (2007).

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Acanthaceae									
	Acanthus mollis	bear's breech		○					●
Aceraceae									
	Acer negundo	box elder			●				
Agavaceae									
	Agave americana	American century plant		○			●		●
	Hesperoyucca whipplei	our lord's candle						*	
	Phormium tenax	New Zealand flax		○			●		
	Yucca aloifolia	aloe yucca		○					
	Yucca elephantipes	spineless yucca							●
	Yucca gloriosa	moundlily yucca		○					
Aizoaceae									
	Aptenia cordifolia	heartleaf iceplant		○			●		
	Carpobrotus chilensis	sea fig		○	●		●		
	Carpobrotus edulis [incl. hybrid]	hottentot fig, freeway iceplant	●	●	●		●		
	Conicosia pugioniformis	narrow-leaved iceplant		○	●		●		
	Drosanthemum floribundum	showy dewflower	●	○	●		●		
	Lampranthus filicaulis	Redondo creeper		●					
	Malephora crocea	coppery mesemb		○					
	Mesembryanthemum crystallinum	ice plant		●					
	Mesembryanthemum nodiflorum	slender-leaf iceplant			○				
	Tetragonia tetragonioides	New Zealand-spinach	○	●	●		●		
Alismataceae									
	Alisma lanceolatum	lanceleaf water plantain					●		
Amaranthaceae									
	Amaranthus albus	tumbleweed			●			●	●
	Amaranthus deflexus	largefruit amaranth		○			●		
	Amaranthus retroflexus	redroot amaranth						●	●
	Rhus integrifolia	lemonade sumac		●					
	Schinus molle	pepper tree		○					●

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Apiaceae									
	Anthriscus caucalis	burr chervil	●	●	●		●	●	●
	Apium graveolens	wild celery		●	●			●	
	Conium maculatum	poison hemlock	●	●	●	●	●	●	●
	Daucus carota	Queen Anne's lace, wild carrot		●	○		●		
	Foeniculum vulgare	sweet fennel		●	●	●	●		●
	Petroselinum crispum	parsley		○					
	Scandix pecten-veneris	shepherd's needle		●	●	ɵ	●	○	●
	Torilis arvensis	spreading hedgeparsley		●	●		●	●	●
	Torilis nodosa	knotted hedgeparsley		●		ɵ	●		●
Apocynaceae									
	Nerium oleander	oleander		●					●
	Trachelospermum jasminoides	confederate jasmine							●
	Vinca major	periwinkle	●	●	●	●	●	●	●
Aquifoliaceae									
	Ilex aquifolium	English holly		●	●		●		
Araceae									
	Arum italicum	Italian lords and ladies			○				
	Zantedeschia aethiopica	calla lily	●	●	●	●	●		●
Araliaceae									
	Hedera canariensis	Algerian ivy		●	●				●
	Hedera helix	English ivy	●	●	●	●	●		●
Arecaceae									
	Phoenix canariensis	Canary Island date palm							●
	Washingtonia filifera	Washington fan palm			●				●
	Washingtonia robusta	Washington fan palm			●				●
Asteraceae									
	Ageratina adenophora	thoroughwort, crofton weed		●					
	Anthemis cotula	dog fennel	○	○	○		●	●	
	Arctotheca calendula	capeweed		●	●	●	●		
	Artemisia biennis	biennial wormwood		○			○	●	
	Bellis perennis	English daisy, lawn daisy	○	●	●	ɵ	●		
	Calendula arvensis	field marigold		●			●		

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Asteraceae, continued									
	Carduus acanthoides	plumeless thistle		○			●		
	Carduus pycnocephalus	Italian thistle	●	●	●	●	●	●	●
	Carduus tenuiflorus	slender-flowered thisle		○			●	●	
	Carthamus lanatus	woolly distaff thistle		○			●		
	Centaurea calcitrapa	purple starthistle		●		●	●		●
	Centaurea diluta	North African knapweed		○					
	Centaurea iberica	Iberian starthistle					○		
	Centaurea melitensis	Napa thistle, tocalote		●	●		●	●	●
	Centaurea solstitialis	yellow starthistle	○	●	○		●	●	●
	Chamomilla suaveolens	pineappleweed	●	●	●		●	●	●
	Chrysanthemum coronarium	crowndaisy		●	●				
	Chrysanthemum frutescens	marguerite		○					
	Chrysanthemum segetum	corndaisy		○			●		
	Cichorium intybus	chicory		○	●		●		●
	Cirsium arvense	Canada thistle		●	○				
	Cirsium vulgare	bull thistle	●	●	●	●	●	●	●
	Conyza bonariensis	asthmaweed		○	●		○		●
	Conyza floribunda	asthmaweed			●		●		
	Cotula australis	Australian waterbuttons		●	●		●		
	Cotula coronopifolia	brassbuttons	○	●	●	●	●	●	
	Crepis capillaris	smooth hawksbeard		○			○		
	Crepis vesicaria	beaked hawksbeard		○					
	Cynara cardunculus	artichoke thistle, cardoon		○	●	○			●
	Cynara scolymus	globe artichoke		○					
	Delairea odorata	cape ivy	●	●	●		●		
	Erechtites glomerata	Australian fireweed, cutleaf burnweed		●	●	○	●		
	Erechtites hieracifolia	burnweed					○		
	Erechtites minima	Australian fireweed, coastal burnweed	●	●	●	●	●		
	Erigeron karvinskianus	Latin American fleabane		●			●		

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Asteraceae, continued									
	Filago [*Logfia*] *gallica*	narrowleaf cottonrose		●	●	●	●	●	●
	Filago pyramidata	broadleaf cottonrose		○					
	Gnaphalium luteoalbum	Jersey cudweed		●	●	●	●	●	●
	Hedypnois cretica	Cretanweed		○	●				
	Helianthus annuus	annual sunflower							●
	Helichrysum petiolare	licorice plant		●			○		
	Hypochaeris glabra	smooth catsear	○	●	●	●	●	●	●
	Hypochaeris radicata	hairy cat's ear, false dandelion	○	●	●	●	●	●	●
	Lactuca biennis	wild blue lettuce		○			●		
	Lactuca saligna	willowleaf lettuce		●	●	●	●	○	
	Lactuca serriola	prickly lettuce		○	●		●	●	●
	Lactuca virosa	bitter lettuce							●
	Lapsana communis	nipplewort		○			●		
	Leontodon taraxacoides [incl. ssp. *longirostris*]	hairy hawkbit		●	●		●		
	Leucanthemum maximum	max chrysanthemum		●			●		
	Leucanthemum vulgare	ox-eye daisy		●			●		
	Olearia traversii	daisy bush		●					
	Picris echioides	bristly oxtongue	●	●	●	●	●	ө	●
	Senecio elegans	redpurple ragwort		●	●				
	Senecio sylvaticus	woodland ragwort		●			●		
	Senecio vulgaris	common groundsel		●	●		●	●	●
	Silybum marianum	blessed milkthistle	○	●	●	●	●	●	●
	Soliva sessilis	field soliva		●	●		●		●
	Sonchus arvensis	perennial sowthistle					○		
	Sonchus asper ssp. *asper*	spiny sowthistle			●	●	●	●	●
	Sonchus oleraceus	annual sowthistle	●	●	●	●	●	●	●
	Tanacetum parthenium	feverfew		○	ө		○		
	Taraxacum officinale	common dandelion	○	●	●	●	●	●	●
	Tolpis [*Crepis*] *barbata*	Eurpoean umbrella milkwort					●		
	Tragopogon dubius	yellow salsify, goat's beard, oyster plant						●	

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Asteraceae, continued									
	Tragopogon porrifolius	purple salsify		●	○				○
	Urospermum picroides	prickly goldenfleece		●					
Basellaceae									
	Anredera cordifolia	Madeira vine		○					
Berberidaceae									
	Berberis darwinii	Darwin's berberis		○			●		
Betulaceae									
	Betula nigra	river birch							●
Bignoniaceae									
	Campsis radicans	trumpet creeper							●
	Tecoma capensis	cape honeysuckle							●
Boraginaceae									
	Borago officinalis	common borage			●				
	Echium candicans	pride of Madeira	●	●	●		●		
	Echium plantagineum	salvation jane		○			○		
	Echium vulgare	common vipersbugloss			○				
	Myosotis discolor	yellowandblue forget-me-not		○	●		●		
	Myosotis latifolia	broadleaf forget-me-not		●	○	●	●		
	Myosotis scorpioides	forget-me-not					○		
	Myosotis sylvatica	woodland forget-me-not				●			
Brassicaceae									
	Alyssum alyssoides	pale alyssum		○					
	Arabidopsis thaliana	mouse-ear cress		○			○		
	Armoracia rusticana	horseradish		○					
	Barbarea verna	early yellowrocket		○	●		●		
	Barbarea vulgaris	winter cress		○					
	Brassica nigra	black mustard	●	●	●	●	○	●	●
	Brassica oleracea	cabbage		○	ɵ				
	Brassica rapa	field mustard	○	●	●	○	●	●	●
	Cakile edentula	American searocket		○	●				
	Cakile maritima	European searocket		●	●		●		
	Capsella bursa-pastoris	shepherd's-purse		●	●	ɵ	●	●	●
	Coronopus didymus	lesser swinecress	●	○	●		●		○
	Hirschfeldia incana	shortpod mustard		●	●		●	●	●
	Lepidium campestre	field pepperweed							○

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Brassicaceae, continued									

Lepidium latifolium	perennial pepperweed, tall whitetop					○		●
Lepidium pinnatifidum	featherleaf pepperweed	○		○				
Lepidium virginicum	poorman's pepper			ɵ				
Lobularia maritima	sweet alyssum	●	●	●		●		
Lunaria annua	annual honesty		○	●	●	○		
Matthiola incana	tenweeks stock		○	ɵ				
Raphanus raphanistrum	wild radish					●		●
Raphanus sativus	wild radish	●	●	●	●	●	●	●
Sinapis alba	white mustard					●		
Sinapis arvensis	charlock		●	○		○		●
Sisymbrium altissimum	tumble mustard		○					
Sisymbrium irio	rocketmustard			●				
Sisymbrium officinale	hedge mustard		●	○		●	○	●
Sisymbrium orientale	oriental hedgemustard		○				●	
Buddlejaceae								
Buddleja davidii	orange eye butterflybush			●				
Campanulaceae								
Campanula medium	Canterbury bells							●
Cannabaceae								
Cannabis sativa	marijuana					○		
Caprifoliaceae								
Lonicera japonica	Japanese honeysuckle		○	●				
Caryophyllaceae								
Cerastium fontanum ssp. *vulgare*	common mouse-ear chickweed			●		●		
Cerastium glomeratum	sticky chickweed	○	●	●		●	●	●
Dianthus deltoides	maiden pink							●
Herniaria hirsuta ssp. *cinerea*	hairy rupturewort						●	
Paronychia franciscana	San Francisco nailwort	ɵ	●	ɵ		○		
Petrorhagia dubia	hairypink			●				
Petrorhagia prolifera	childing pink					○		

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Caryophyllaceae, continued									
	Polycarpon tetraphyllum	fourleaf manyseed	●	●	●		●	●	
	Saponaria officinalis	bouncing bet, soapwort			ө				
	Silene gallica	windmill catchfly	○	●	●	●	●	●	●
	Spergula arvensis ssp. *arvensis*	common sandspurry	●	○	●	ө	●	●	
	Spergularia bocconii	Boccone's sandspurry		○	ө		○		
	Spergularia maritima	media sandspurry		●	●		○		
	Spergularia villosa	hairy sandspurry		○	ө		○		
	Stellaria media	common chickweed	●	●	●	●	●	●	●
	Stellaria pallida	pale chickweed						●	
	Vaccaria pyramidata	cowcockle			ө				
Casuarinaceae									
	Casuarina stricta	beefwood		●					
Celastraceae									
	Euonymus japonica	Japanese spindletree		●					●
Chenopodiaceae									
	Beta vulgaris	common beet		○	○				
	Chenopodium album	lambsquarters, goosefoot	○	○	●		○	●	○
	Chenopodium ambrosioides	Mexican-tea		○	ө		●	●	
	Chenopodium botrys	Jerusalem-oak		○			○		
	Chenopodium macrospermum var. *halophilum*	saltloving goosefoot		○			●		
	Chenopodium multifidum	cutleaf goosefoot	○	○	●				●
	Chenopodium murale	nettle-leaf goosefoot		●	●		●		
	Chenopodium strictum var. *glaucophyllum*	lateflowering goosefoot		○			●		
	Chenopodium vulvaria	stinking goosefoot					●		
	Salsola soda	oppositeleaf Russian thistle			●		○		
	Salsola tragus	prickly Russian thistle						●	
Cistaceae									
	Cistus creticus	Cretan rockrose		○					

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Clusiaceae									
	Hypericum calycinum	Aaron's beard		○	●		○		●
	Hypericum perforatum	Klamathweed		○		○	○		
Commelinaceae									
	Tradescantia fluminensis	white-flowered wandering jew		●	○				
Convolvulaceae									
	Convolvulus arvensis	field bindweed		●	●	○	●	●	●
	Convolvulus cneorum	silverbush							●
	Dichondra micrantha	Asian ponysfoot		●					
	Ipomoea mutabilis	oceanblue morning-glory		○	ɵ				
Cornaceae									
	Aucuba japonica	gold-dust plant							●
Crassulaceae									
	Crassula multicava	Cape Province pygmyweed			ɵ				
	Crassula tillaea	moss pygmyweed						●	
	Sedum dendroideum	tree stonecrop		●					
	Sedum telephium	witch's moneybags							●
Cupressaceae									
	Cupressocyparis leylandii	Leyland cypress							●
	Cupressus funebris	Chinese weeping cypress							●
	Cupressus macrocarpa	Monterey cypress	●	●	●	●	●		
	Juniperus communis	common juniper					●		
	Thuja occidentalis	eastern white cedar, arborvitae							●
Cyperaceae									
	Cyperus difformis	variable flatsedge						●	
	Cyperus involucratus	umbrella flatsedge		○	○		○		
Dipsacaceae									
	Dipsacus fullonum	common teasel, Fuller's teasel		●	ɵ		●		
	Dipsacus sativus	Indian teasel		●	ɵ		●		
	Scabiosa atropurpurea	mourningbride		●	●		○		
	Scabiosa stellata	starflower pincushions		○					

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Ebenaceae									
	Diospyros kaki	Japanese persimmon							●
Elaeagnaceae									
	Elaeagnus angustifolia	Russian-olive, oleaster			○				
Ericaceae									
	Arbutus unedo	strawberry tree							●
Euphorbiaceae									
	Chamaesyce maculata	spotted spurge						●	●
	Euphorbia lathyris	gopher plant, caper spurge		●		○	●		●
	Euphorbia oblongata	eggleaf or oblong spurge		○		○	●		●
	Euphorbia peplus	petty spurge		●	●	○	●		●
Fabaceae									
	Acacia baileyana	cootamundra wattle		○					
	Acacia dealbata	silver wattle		○		○			
	Acacia decurrens	green wattle		○	●	○			
	Acacia farnesiana	sweet acacia				●			
	Acacia longifolia	Sydney golden wattle	○	●	●	ɵ	○		●
	Acacia mearnsii	black wattle		○	●		○		
	Acacia melanoxylon	blackwood acacia		●	●	●	○		
	Acacia redolens	bank catclaw		○					
	Acacia retinodes	everblooming acacia			●				
	Acacia sclerosperma	acacia		○					
	Acacia verticillata	prickly Moses		●	●		○		
	Albizia lophantha	silk tree, cape wattle		●	●		○		
	Ceratonia siliqua	St. John's bread, carob							●
	Cytisus multiflorus	white spanishbroom		○					
	Cytisus scoparius	Scotch broom		●	●	●	●		
	Cytisus striatus	Portugese broom, striated broom		●					
	Genista monspessulana	French broom	●	●	●	●	●		●
	Gleditsia triacanthos	common honeylocust							●
	Lathyrus angulatus	angled pea					●		
	Lathyrus hirsutus	Caley pea					●		
	Lathyrus latifolius	everlasting pea, perennial pea		●	●	●	●		●
	Lathyrus odoratus	sweetpea		●	○				
	Lathyrus sphaericus	grass pea		○					

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Fabaceae, continued									
	Lathyrus tingitanus	Tangier pea		○					
	Lotus angustissimus	slender birdsfoot trefoil					○		
	Lotus corniculatus	birdsfoot trefoil	○	●	●	●	●		●
	Lotus tenuis	narrowleaf bird's-foot trefoil					○		
	Lupinus succulentus	hollowleaf annual lupine			*				
	Medicago arabica	spotted burclover		●			●		●
	Medicago lupulina	black medick		●	●		○		
	Medicago polymorpha	California burclover	●	●	●	○	●	●	●
	Medicago sativa	alfalfa		○	ɵ		○		
	Melilotus alba	white sweetclover		●	●		●	●	
	Melilotus indica	sourclover	●	●	●		●	●	●
	Melilotus officinalis	yellow sweet-clover		○	●				
	Melilotus suaveolens	sweetclover		○					
	Pisum sativum	garden pea		○			○		
	Prosopis glandulosa var. *torreyana*	western honey mesquite							●
	Robinia pseudoacacia	black locust		○			●		●
	Spartium junceum	Spanish broom		○	○	●			
	Trifolium aureum	golden hop clover							
	Trifolium campestre	field (big-hop) clover	○	●	●		●		
	Trifolium cernuum	nodding clover					●		
	Trifolium dubium	little hop clover		●	●		●		●
	Trifolium fragiferum	strawberry clover			●		●		
	Trifolium glomeratum	clustered clover		○	●		●		●
	Trifolium hirtum	rose clover		●	●		●	ɵ	●
	Trifolium hybridum	alsike clover			●				
	Trifolium incarnatum	crimson clover							●
	Trifolium pratense	red clover		○	ɵ		●		
	Trifolium repens	white clover	○	●	●	ɵ	●		
	Trifolium subterraneum	subterranean clover		●	●		●		●
	Trifolium tomentosum	woolly clover					●		
	Ulex europaea	gorse, furze		●	○		●		
	Vicia benghalensis	purple vetch		●	●		●		●

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Fabaceae, continued									
	Vicia faba	horsebean		●					
	Vicia hirsuta	tiny vetch		●			●		
	Vicia sativa	common Vetch	●	●	●	●	●		●
	Vicia sativa ssp. *nigra*	common vetch	●	●	●	○	●		●
	Vicia sativa ssp. *sativa*	garden vetch		●	●		○	●	●
	Vicia tetrasperma	lentil vetch					○		
	Vicia villosa (incl. ssp. *villosa*)	hairy vetch		●	●				●
	Vicia villosa ssp. *varia*	winter vetch						●	
	Wisteria sinensis	Chinese wisteria							●
Fagaceae									
	Quercus suber	cork oak		○					●
Fumariaceae									
	Fumaria officinalis	drug fumitory	○		●				
	Fumaria parviflora	fine-leaf fumitory		○	●				
Geraniaceae									
	Erodium botrys	longbeak stork's bill		●	●	●	●	●	●
	Erodium brachycarpum	shortfruit stork's bill		○	●			●	●
	Erodium cicutarium	redstem filaree	○	●	●	●	●	●	●
	Erodium malacoides	Mediterranean stork's bill					●		
	Erodium moschatum	musky stork's bill		●	●		●	●	●
	Geranium anemonifolium [*palmatum*]	Canary Island geranium			●				
	Geranium dissectum	cutleaf geranium	○	●	●	○	●	●	●
	Geranium molle	dovefoot geranium		●	●	●	●		●
	Geranium potentilloides	cinquefoil geranium		○			●		
	Geranium pusillum	small geranium		○	●	●			
	Geranium retrorsum	New Zealand geranium		○	●		●		
	Geranium robertianum	Robert geranium, herb robert			●		○		
	Geranium solanderi	Solander's geranium		○					
	Pelargonium grossularioides	gooseberry geranium		○			●		
	Pelargonium hortorum	zonal geranium							●

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Geraniaceae, continued									
	Pelargonium peltatum	ivyleaf geranium		○					
	Pelargonium quercifolium	oakleaf geranium		●					
	Pelargonium vitifolium	grapeleaf geranium		○					
	Pelargonium zonale	horseshoe geranium		○					
Grossulariaceae									
	Escallonia macrantha	escallonia	●		○				
	Escallonia rubra	redclaws		○	○				
Gunneraceae									
	Gunnera tinctoria	Chilean gunnera		○			●		
Haloragaceae									
	Myriophyllum aquaticum	parrot's-feather		○			●		
	Myriophyllum spicatum	Eurasian watermilfoil		○	ɵ				
Hydrangeaceae									
	Carpenteria californica	tree anemone							●
	Deutzia scabra	fuzzy deutzia							●
	Hydrangea macrophylla	hydrangea							●
	Philadelphus coronarius	mock-orange							●
Hydrocharitaceae									
	Egeria densa	Brazilian elodea or waterweed					●		
Iridaceae									
	Chasmanthe aethiopica	chasmanthe		○					●
	Chasmanthe floribunda	African cornflag		●	●				
	Crocosmia X *crocosmiiflora*	crocosmia, montbretia		●	●	●	●		
	Iris germanica	orris							●
	Iris pseudacorus	yellow flag					○	ɵ	
	Ixia maculata	spotted African cornlily		○					
	Libertia formosa	snowy mermaid		○	ɵ				
	Romulea rosea var. *australis*	rosy sandcrocus		●			●		
	Sparaxis tricolor	wandflower		●			○		
	Watsonia borbonica	bugle-lily		●					
	Watsonia marginata	fragrant bugle-lily		○					
	Watsonia meriana	bulbil bugle-lily		●	○		○		

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Juglandaceae									
	Carya illinoinensis	pecan							●
	Juglans californica var. *hindsii*	Northern California black walnut			*			*	*
	Juglans regia	English walnut							●
Juncaceae									
	Juncus capitatus	leafybract dwarf rush			●				
Lamiaceae									
	Lamium amplexicaule	common henbit		○	●		●	●	●
	Lamium purpureum	purple deadnettle		●			○		
	Lavandula angustifolia	English lavender							●
	Lavandula dentata	French lavender							●
	Marrubium vulgare	horehound		●	○	●	●	●	
	Melissa officinalis	common balm							●
	Mentha pulegium	pennyroyal		●	●	●	●		
	Mentha spicata var. *spicata*	spearmint		○	●			●	●
	Mentha suaveolens	apple mint					○		
	Mentha X *piperita*	peppermint		○	●	●	●	●	
	Rosmarinus officinalis	rosemary		○					●
	Salvia greggii	autumn sage							●
	Salvia splendens	scarlet sage							●
Lauraceae									
	Cinnamomum camphora	camphor tree							●
	Laurus nobilis	sweet bay							●
	Persea americana	avocado			○				
Liliaceae									
	Agapanthus africanus	lily of the Nile		●					
	Agapanthus praecox [incl. ssp. *orientalis*]	agapanthus, African-lily		●					●
	Allium neapolitanum	white garlic							●
	Allium triquetrum	threecorner leek	●	●	●	ɵ	○		
	Aloe arborescens	candelabra aloe		○					
	Aloe saponaria	aloe		●					
	Amaryllis belladonna	belladonna lily	●	○	●		●		●
	Cordyline australis	cabbage tree		●	●				
	Hyacinthus orientalis	garden hyacinth		○	ɵ				

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Liliaceae, continued									
	Kniphofia uvaria	redhot poker		●	●		○		●
	Leucojum aestivum	summer snowflake		●					
	Muscari botryoides	common grape hyacinth		○					
	Narcissus pseudonarcissus	common daffodil		○			●		
	Narcissus tazetta	cream narcissus					○		
	Narcissus X *medioluteus*	primrose peerless		○			●		
	Nothoscordum gracile	slender false garlic		●					
Linaceae									
	Linum bienne	pale flax		●		●	●		
	Linum usitatissimum	cultivated flax		○			●		
Lythraceae									
	Lythrum hyssopifolia	hyssop loosestrife		●	○	ɵ	●	●	●
	Lythrum tribracteatum	threebract loosestrife		○					
Malvaceae									
	Lavatera arborea	tree mallow	○	●	●				
	Lavatera assurgentiflora	island mallow		○	○				
	Lavatera cretica	Cornish mallow		○	●				●
	Malva neglecta	common mallow, cheeseweed		○	○				
	Malva nicaeensis	bull mallow		●	●		●		
	Malva parviflora	cheeseweed		●	●		●	●	
	Malva sylvestris	high mallow	○	●	●	○			
	Malvella leprosa	alkali mallow							●
	Modiola caroliniana	Carolina bristlemallow		○	●		●		
Moraceae									
	Ficus carica	edible fig		●					●
	Ficus pumila	creeping fig		●					●
	Morus alba	white mulberry							●
Myoporaceae									
	Myoporum laetum	myoporum	●	●	●		○		
Myrtaceae									
	Callistemon citrinus	crimson bottlebrush			●				●
	Eucalyptus camaldulensis	river redgum		●					●
	Eucalyptus cladocalyx	sugar gum							●

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Myrtaceae, continued									
	Eucalyptus cornuta	yate		○					
	Eucalyptus crebra	narrowleaf red ironbark							●
	Eucalyptus ficifolia	redflower gum		○	●				
	Eucalyptus globulus	bluegum eucalyptus		●	●	●	●		●
	Eucalyptus goniocalyx	mountain graygum		○					
	Eucalyptus leucoxylon	white ironbark		○					
	Eucalyptus polyanthemos	redbox		○	○				●
	Eucalyptus pulverulenta	silver mountain gum		○					
	Eucalyptus resinifera	redmahogany							●
	Eucalyptus salicifolia	blackpeppermint		○					
	Eucalyptus saligna	Sydney bluegum							●
	Eucalyptus sideroxylon	red ironbark		●					●
	Eucalyptus tereticornis	forest redgum		●					
	Eucalyptus viminalis	manna gum				●			●
	Feijoa sellowiana	feijoa							●
	Leptospermum laevigatum	Australian teatree		●	●				
	Myrtus communis	myrtle							●
	Syzygium paniculatum	brush cherry		○					
Nyctaginaceae									
	Bougainvillea spectabilis	bougainvillea		○					
Nymphaeaceae									
	Nymphaea odorata	white waterlily					○		
Oleaceae									
	Ligustrum japonicum	Japanese privet			○				
	Ligustrum ovalifolium	California privet		○					●
	Olea europaea	olive							●
	Osmanthus heterophyllus	holly osmanthus							●
	Syringa vulgaris	common lilac		○					●
Onagraceae									
	Camissonia cheiranthifolia ssp. *suffruticosa*	shrubby beach suncup			*				
	Fuchsia hybrida	hybrid fuchsia		○	○				

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Onagraceae, continued									
	Fuchsia magellanica	hardy fuchsia		●					
	Gaura lindheimeri	Lindheimer's beeblossom							●
	Gaura parviflora	smallflowered gaura		●					
Orchidaceae									
	Epipactis helleborine	broadleaf helleborine		●	●	○			
Oxalidaceae									
	Oxalis corniculata	creeping woodsorrel		●	●		●		●
	Oxalis incarnata	crimson woodsorrel		○	●				
	Oxalis pes-caprae	Bermuda buttercup	●	●	●	●	●		●
	Oxalis rubra	windowbox woodsorrel		●	○		○		
Papaveraceae									
	Papaver rhoeas	corn poppy					○		
	Romneya trichocalyx	bristly Matilija poppy			●				
Phytolaccaceae									
	Phytolacca americana	pokeweed, pigeonberry			●				
Pinaceae									
	Cedrus deodara	Deodar cedar		○	●				●
	Cedrus libani [incl. *atlantica*]	Atlas cedar							●
	Picea glauca	white spruce							●
	Picea pungens	blue spruce							●
	Pinus canariensis	Canary Island pine			●				
	Pinus contorta [incl. var. *contorta*]	shore pine		●	●		●		
	Pinus monophylla	singleleaf pinyon		○					
	Pinus ponderosa	ponderosa pine		○					
	Pinus radiata	Monterey pine		●	●	●	●		
	Pinus thunbergiana	Japanese black pine					○		
	Pinus torreyana	Torrey pine		●					
Pittosporaceae									
	Pittosporum crassifolium	stiffleaf cheesewood	●	●	●				
	Pittosporum tenuifolium	tawhiwhi			○				
	Pittosporum tobira	Japanese pittosporum							●
	Pittosporum undulatum	Victorian box		●	●		●		

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Plantaginaceae									
	Plantago coronopus	buckhorn plantain	●	●	●		●	●	
	Plantago lanceolata	English or lanceleaf plantain, ribgrass	●	●	●	●	●	●	●
	Plantago major	broadleaf or common plantain	○	●	●	●	●	●	●
Platanaceae									
	Platanus racemosa	California sycamore		*			*		
Poaceae									
	Agrostis avenacea	Pacific bentgrass					●		
	Agrostis capillaris	colonial bentgrass		○	●		●		
	Agrostis gigantea	redtop		●	●				
	Agrostis stolonifera	creeping bentgrass	●	●	●		●		●
	Agrostis viridis	green bent	●	○	●		●	●	
	Aira caryophyllea	silver hairgrass	●	●	●	●	●	●	●
	Aira elegantissima	elegant European hairgrass		○					
	Aira praecox	yellow hairgrass		○			●		
	Alopecurus pratensis	meadow foxtail		●			●		
	Ammophila arenaria	European beachgrass		●	●		●		
	Ammophila breviligulata	American beachgrass		○					
	Anthoxanthum odoratum	sweet vernalgrass		○	●		●		
	Arrhenatherum elatius	tall oatgrass		●			●		
	Arundo donax	giant reed		●	●		●		●
	Avena barbata	slender oat	●	●	●	○	●	●	●
	Avena fatua	wild oat	●	●	●	ɵ	●	●	●
	Avena sativa	common or cultivated oat		●	○		●		
	Brachypodium distachyon	purple false brome		●			●		
	Briza maxima	big quakinggrass		●	●	●	●		
	Briza minor	little quakinggrass		●	●	●	●		●
	Bromus arenarius	Australian brome						●	
	Bromus catharticus	rescue grass		●	●				
	Bromus diandrus	ripgut brome	●	●	●	●	●	●	●
	Bromus hordeaceus	soft brome	●	●	●	●	●	●	●
	Bromus madritensis ssp. *madritensis*	compact brome						●	
	Bromus madritensis ssp. *rubens*	red brome		●	○	○	●	●	●
	Bromus stamineus	roadside brome	○	○	●				

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Poaceae, continued									
	Bromus sterilis	poverty brome			●				
	Bromus tectorum	cheat grass, downy brome		●					
	Bromus trinii [*berteroanus*]	Chilean brome						●	
	Cortaderia jubata	Andean or purple pampas grass, jubata grass	●	●	●	●	●		
	Cortaderia selloana	Uruguayan pampas grass		●	●		●		
	Crypsis schoenoides	swamp prickle grass						●	●
	Cynodon dactylon	Bermudagrass		●	●			●	●
	Cynosurus echinatus	bristly dogstail grass, hedgehog dogtail	●	●	●	●	●	●	●
	Dactylis glomerata	orchard grass, cocksfoot		●	●		●	●	●
	Danthonia [*Rytidosperma*] *pilosa*	hairy oatgrass		●			○		
	Digitaria sanguinalis	crabgrass		●			●		
	Echinochloa crus-galli	barnyard grass			●		○		
	Ehrharta calycina	perennial veldt grass		○			○		
	Ehrharta erecta	panic veldt grass		●	●		●		
	Festuca arundinacea	tall fescue		●	○	●	●		
	Gastridium ventricosum	nit grass		●		●	●	●	●
	Hainardia cylindrica	barbgrass		●	●		●		
	Holcus lanatus	velvet grass, Yorkshire fog	●	●	●	●	●		
	Hordeum marinum ssp. *gussonianum*	Mediterannean barley		●	●		●		●
	Hordeum murinum ssp. *glaucum*	smooth barley		○	●		○		
	Hordeum murinum ssp. *leporinum*	leporinum barley	●	●	●	●	●	●	●
	Hordeum vulgare [incl. var. *vulgare*]	common barley		○	○		●	●	
	Lagurus ovatus	harestail grass		●	●		●		
	Lamarckia aurea	goldentop grass		●				●	●
	Lolium multiflorum	Italian or annual ryegrass	●	●	●		●	●	●
	Lolium perenne	Italian or perennial ryegrass	●	●	●		●	●	

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Poaceae, continued									
	Lolium [*Festuca*] *pratense*	meadow fescue		●			○		
	Lolium temulentum	darnel		○	●			●	
	Panicum acuminatum	panic grass			○				
	Panicum miliaceum	proso millet			●				
	Parapholis incurva	curved sicklegrass	○	●	●		●		
	Paspalum dilatatum	dallis grass		●	●		●		
	Pennisetum clandestinum	Kikuyu grass		●	●		●		
	Phalaris aquatica	Harding grass		●	●	●	●	●	●
	Phalaris arundinacea	reed canary grass		●			●		
	Phalaris canariensis	annual canarygrass		●					●
	Phalaris minor	littleseed canarygrass		●			○		
	Phalaris paradoxa	hood canarygrass		●					●
	Piptatherum miliaceum	smilo grass			●			●	
	Piptochaetium setosum	bristly speargrass		●			○		
	Piptochaetium stipoides	purple spear grass		○					
	Poa annua	annual bluegrass	●	●	●		●	●	●
	Poa bulbosa	bulbous bluegrass		○			○	●	●
	Poa compressa	flat-stem blue grass		○			○		
	Poa palustris	fowl bluegrass					●		
	Poa pratensis ssp. *pratensis*	Kentucky bluegrass		●	ɵ	○	●		●
	Poa trivialis	rough bluegrass		○			●		
	Polypogon australis	Chilean rabbit's-foot grass					○		
	Polypogon interruptus	ditch rabbit's-foot grass	●	●	●	●	●	●	
	Polypogon maritimus	Mediterranean rabbitsfoot grass			●				
	Polypogon monspeliensis	rabbitfoot beardgrass	●	●	●	●	●	●	●
	Setaria pumila	yellow bristlegrass					●		
	Setaria viridis	green bristlegrass					○		
	Sorghum halepense	Johnson grass					●		
	Spartina alterniflora	Atlantic, saltmarsh, or smooth cordgrass		●			●		
	Triticum aestivum	common or winter wheat		○	ɵ				●

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Poaceae, continued									
	Vulpia bromoides	brome fescue		●	●		●	●	●
	Vulpia myuros var. *hirsuta*	rattail fescue		●	○	○	●	●	●
	Vulpia myuros var. *myuros*	rattail fescue		●	○			●	●
	X *Agropogon littoralis*	coast agropogon			○				
Polygonaceae									
	Eriogonum fasciculatum var. *foliolosum*	Eastern Mojave buckwheat		*			*		
	Muehlenbeckia complexa	maidenhair vine	●	●	●				
	Polygonum arenastrum	oval-leaf knotweed	●	●	●		●	●	●
	Polygonum aviculare	prostrate knotweed	○	ɵ	●		○		
	Polygonum convolvulus	pink smartweed			ɵ				
	Polygonum cuspidatum	Japanese knotweed			○				
	Polygonum persicaria	lady's-thumb		●	○		●		
	Rumex acetosella	sheep sorrel	●	●	●	○	●	●	●
	Rumex conglomeratus	clustered dock		●	●		●		●
	Rumex crispus	curly dock	●	●	●		●	●	●
	Rumex obtusifolius	bitter dock		●	ɵ				
	Rumex pulcher	fiddle dock	○	●	●	ɵ	●		●
Pontederiaceae									
	Eichhornia crassipes	water hyacinth		●					
Portulacaceae									
	Portulaca oleracea	purslane		○	●			●	●
Primulaceae									
	Anagallis arvensis	scarlet pimpernel	●	●	●	●	●	●	●
Punicaceae									
	Punica granatum	pomegranate							●
Ranunculaceae									
	Caltha palustris	yellow marsh-marigold					●		
	Clematis armandii	Armand clematis							●
	Ranunculus muricatus	spinyfruit buttercup	○	●	●	ɵ	●		●
	Ranunculus repens	creeping buttercup		●			●		
Rhamnaceae									
	Ceanothus griseus	Carmel ceanothus		*	*				

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Rosaceae									
	Chaenomeles lagenaria	Japanese quince							●
	Cotoneaster dammeri	bearberry cotoneaster				○			●
	C. franchetii	orange cotoneaster		○	●		●		
	C. lacteus	milkflower cotoneaster			●				●
	C. pannosus	silverleaf cotoneaster		●			●		●
	Crataegus laevigata	smooth or English hawthorn							●
	C. monogyna	singleseed hawthorn		●	○		○		
	Cydonia oblonga	quince							●
	Duchesnea indica	mock-strawberry		●	○	○	○		
	Eriobotrya japonica	loquat		●		●			●
	Malus floribunda	Japanese flowering crabapple							○
	M. sylvestris [*domestica*]	cultivated apple		●	●	ɵ			●
	Prunus armeniaca	apricot							●
	P. avium	bird cherry		●	○	ɵ			
	P. cerasifera	cherry plum		●			●		●
	P. domestica	plum							●
	P. dulcis	almond							●
	P. laurocerasus	cherry laurel			○				
	P. persica	peach							●
	P. salicina	Japanese plum							●
	Pyracantha angustifolia	narrowleaf firethorn		●	●		○		●
	P. coccinea	scarlet firethorn							●
	Pyrus communis	pear							●
	Rhaphiolepis indica	Indian hawthorn							●
	Rosa banksiae	Lady Banks rose							●
	Rosa eglanteria	sweetbriar rose		●			●		
	Rosa laevigata	camelia rose							●
	Rosa X *harisonii*	Harison's yellow rose							●
	Rubus discolor [*procerus*]	Himalayan blackberry		●	●	●	●	●	●
	Sanguisorba minor ssp. *muricata*	small or ganden burnet		○			●		
	Sorbus aucuparia	European mountain ash		●			○		
	Spiraea prunifolia	bridalwreath spirea							●

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Rubiaceae									
	Coprosma repens	creeping mirrorplant	●	●	●				
	Galium divaricatum	Lamarck's bedstraw		●			●		
	Galium murale	yellow wall bedstraw					●	●	●
	Galium nuttallii	climbing bedstraw		●	●	ө			
	Galium parisiense	wall bedstraw						●	●
	Sherardia arvensis	field madder		●	●	ө	●		
Rutaceae									
	Choisya ternata	Mexican orange		○			○		
	Citrus limon	lemon							●
	Citrus sinensis	orange							●
	Ruta chalepensis	fringed rue					○		
Salicaceae									
	Populus alba	white poplar		●			○		
	Salix babylonica	weeping willow		●	○				
Saxifragaceae									
	Bergenia crassifolia	elephant ears							●
Scrophulariaceae									
	Bellardia trixago	bellardia		●					●
	Cymbalaria muralis	Kenilworth ivy		●	ө		●		
	Digitalis purpurea	purple foxglove		●	●		●		
	Hebe X *franciscana*	Francisco hebe		●	ө				
	Kickxia elatine	sharpleaf fluellin							●
	Linaria vulgaris	butter and eggs		●			●		
	Parentucellia latifolia	broadleaf glandweed					○		
	Parentucellia viscosa	yellow glandweed		●			○		
	Verbascum blattaria	moth mullein		●			○	●	
	Verbascum thapsus	woolly mullein						ө	
	Veronica anagallis-aquatica	water speedwell		●			○	●	
	Veronica arvensis	common speedwell		●				●	
	Veronica catenata	sessile water-speedwell, chain speedwell						●	
	Veronica filiformis	threadstalk speedwell			○				
	Veronica persica	Persian speedwell		●			●	●	●
Simaroubaceae									
	Ailanthus altissima	tree-of-heaven		●				ө	●
Solanaceae									
	Datura stramonium	jimsonweed		●			●		

Family	Scientific Name	Common Name	Fort Point	Golden Gate	Presidio	Muir Woods	Point Reyes	Pinnacles	John Muir
Solanaceae, continued									
	Nicotiana acuminata var. *multiflora*	manyflower tobacco					○	●	
	Nicotiana glauca	tree tobacco		●				●	●
	Salpichroa origanifolia	lily-of-the-valley-vine					●		
	Solanum aviculare	New Zealand nightshade		●	●				
	Solanum furcatum	forked nightshade		●	●				
	Solanum marginatum	white-margined nightshade		●					
	Solanum nigrum	black nightshade		●	●		○		
	Solanum physalifolium	hoe nightshade		●			●		
	Solanum rostratum	buffalo berry			●				
Tamaricaceae									
	Tamarix chinensis	saltcedar		●					
	Tamarix gallica	French tamarisk							●
Taxodiaceae									
	Metasequoia glyptostroboides	dawn redwood		●			●		
	Sequoia sempervirens	coast redwood			*			*	
	Sequoiadendron giganteum	giant sequoia		●	●				
Thymelaceae									
	Daphne odora	fragrant daphne							●
Tropaeolaceae									
	Tropaeolum majus	nasturtium	●	●	●	●	●		
Ulmaceae									
	Ulmus pumila	Siberian elm							●
Urticaceae									
	Parietaria judaica	spreading pellitory		●	●		●		
	Urtica urens	dwarf nettle		●	●	○	●	●	
Valerianaceae									
	Centranthus ruber	red valerian		●	●				●
Verbenaceae									
	Phyla nodiflora var. *nodiflora*	turkey tangle fogfruit							●
	Verbena bonariensis	purpletop vervain		●	○				
Vitaceae	*Parthenocissus vitacea*	woodbine							●
	Vitis vinifera	cultivated grape							●
Zygophyllaceae									
	Tribulus terrestris	caltrop, puncturevine							●

● Present ○ Thought to occur * Within native range, but not a native population ɵ Historic

Appendix B: Subwatershed Ranking Process for GOGA and PORE

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
	February 2009	Williams, A. and Brown, D.	Compiled from process notes	Response to review comments	1.0

Subwatershed prioritization is not a small task, and the process will differ among parks, as GIS data will be different for every area. The subwatershed prioritization GIS/database process should be handled by someone with reasonably good GIS skills. The steps that need to be done are described in general terms because data will vary, and people's software preferences will vary. First a subwatershed (or whatever you are using as prioritization areas) layer will need to be selected. Second, a project (park) boundary layer will need to be selected. The subwatershed layer and every other data layer will need to be clipped to the park boundary. A spreadsheet will need to be produced showing acres of each subwatershed within (clipped) the park boundaries.

The ranking matrix for GOGA was run using data from GIS layers from parks and the Exotic Plant Management Team. Coverages containing information from three general areas were added to the project: management priority, risk, and current level of infestation. ArcView 3.3, GeoProcessing Wizard (copyright ESRI 1992-2002), and XTools (Oregon State, 1998 and 2001) were used to compile spatial data for analysis. Coverages of similar types (point, line, or polygon) were combined using GeoProcessing "Merge themes together" into shapefiles and intersect files (GeoProcessing "Intersect two themes") were made for each using subwatersheds as the overlay. XTools "Update perimeter, area, acres, and length" was run for the non-point intersect files to add area or length of features within each subwatershed. The resulting *.dbf files from the intersected themes were imported into an Access database (Priors.mdb, in [inpgogamahe1\Divisions\Network I&M]:\Shared\Vegetation\Invasive Plants\Databases\Prioritization; for PORE, all information can be found in [inppore07]:\GIS\projects1\anwi\ED\dons_work; the database is dons_access_work) and analyzed. The January 2006 version of the "Work Performed" database at GOGA (copy in Prioritization folder), which stores vegetation management activity information was mined for data on number of species and hours of work by subwatershed. Similar species were grouped into guilds (graminoid, herb, forb, shrub/subshrub, vine/groundcover, broom, thistle, and tree; guild assignments are in the PORE-GOGA Veg-Wetland_AnWi database; see below) for analysis. Results of queries from Access database "Prioritization.mdb" were exported to Excel for summary and presentation. Although not every subwatershed was rankable for each factor due to lack of data or out-of-park location, 142 of 157 GOGA subwatersheds were ranked overall; 78 of 125 were ranked for PORE.

The 1994 Vegmap (vegetation_1994.shp) was used to determine exotic-dominated (e.g., California exotic annual grassland or Eucalyptus) and low-risk alliances (native evergreen forests). These were two separate scores: one for exotic alliances, and one for risk alliances.

Table 1. Data from 1994 vegetation map showing top and bottom 10 subwatersheds for at-risk acreages, plus exotic alliance rankings for those subwatersheds.

Subwatershed Name	Acres in Subwatershed	Acres in Park	"Risk" Acres from Vegmap	% Area at Risk	Veg map Risk Rank	Veg map Risk Score	Acres Exotic Alliance	% Area Exotic	Veg map Exotic Rank	Veg map Priority Score
GGNRA28-3	286.462	286.462	276.282	96.4%	1	1	4.612	1.6%	17	1
GGNRA28-2	213.525	213.525	201.06	94.2%	2	1	12.465	5.8%	28	1
GGNRA28-4	278.523	278.523	261.004	93.7%	3	1	1.128	0.4%	5	1
GGNRA7-1	195.266	195.266	179.571	92.0%	4	1	15.692	8.0%	34	1
GGNRA10-1	106.362	106.362	94.92	89.2%	5	1	3.637	3.4%	23	1
GGNRA1-2	229.188	229.188	204.209	89.1%	6	1	18.374	8.0%	33	1
GGNRA2-1	80.508	80.508	71.382	88.7%	7	1	8.34	10.4%	42	1
GGNRA5-2	63.584	63.584	56.128	88.3%	8	1	4.719	7.4%	30	1
GGNRA11-12	138.105	138.105	121.626	88.1%	9	1	13.763	10.0%	39	1
GGNRA10-2	217.226	217.226	190.583	87.7%	10	1	23.972	11.0%	44	0
GGNRA18-4	487.664	487.664	6.052	1.2%	133	-1	319.374	65.5%	127	-1
GGNRA16-20	248.474	34.548	0.244	0.7%	134	-1	0	0.0%	2	1
GGNRA13-4	244.890	244.89	1.028	0.4%	135	-1	0	0.0%	1	1
GGNRA14-1	704.859	704.859	2.113	0.3%	136	-1	7.104	1.0%	11	1
GGNRA26-1	352.511	269.747	0.473	0.2%	137	-1	235.44	87.3%	138	-1
GGNRA26-3	1223.004	1212.806	0.64	0.1%	138	-1	121.258	10.0%	41	1
GGNRA19-4	1410.721	1410.721	0.563	0.0%	139	-1	9.078	0.6%	6	1
GGNRA16-16	48.211	0.611	0	0.0%	140	-1	0.612	100.2%	142	-2
GGNRA26-2	545.132	448.518	0	0.0%	141	-1	290.891	64.9%	126	-1
GGNRA3-3	11.373	11.373	0	0.0%	142	-1	11.373	100.0%	141	-2

Accuracy assessment plots from PORE-GOGA Veg-Wetland Master.mdb (actually a local copy with same information called PORE-GOGA Veg-Wetland AnWi.mdb, in the Prioritization folder) were used for scoring number of species per plot. Number of plots, number of plots per 100 acres, number of exotics, number of exotics per 100 acres, number of guilds, and number of guilds per 100 acres were also extracted but discarded as ranking factors. Of the 108 subwatersheds that had plots, 16 had no exotics; the most was 13. The mean number of exotics per plot was 1.8, and the median was 1.43.

Infrastructure lines were conservatively bufferred at four feet to create an area. Invasives data from coverages presented a large problem: there was no negative data, so areas with no polygons may be infested; there were overlapping coverages and lack of information about what was treated and what still exists, so acreages of "existing" infestations were unreliable. However, percent of area mapped as invasive was used as one of the rankings, because lack of information/bad information (not mapped or mapped but treated) will both yield search time, either from a higher priority by invasives not having been mapped or from staff doing removal of invasives (treated but not mapped). Number of guilds from work performed and staff time spent were also used as scoring items. Staff time was not ranked and broken up into quarters; instead, subwatersheds that were in the mid-range were given an additional point, for the reason similar to the invasives mapping. The range of staff hours was 0-16298, and those in the middle third—25-99—received the point, under the assumption that areas receiving large amounts of work were both heavily infested and well-searched, and areas receiving little or no time were likely not infested. Rare plant data were generally good, and looked at for both number of taxa and total acres; percent of subwatershed acres that were rare plant acreages was used as the scoring factor. Rare animal polygons over-estimated habitat due to unioning errors and large buffers, and included historic populations, so number of taxa was used instead of acres. All acreage percentages were based on the number of acres in the park (determined by subtracting "out of park" alliance acres from subwatershed acres).

Subwatersheds were ranked, and then grouped along the most natural breaks and assigned a score. For example, subwatersheds were put in order based on the percentage of acres at risk for invasion (vegmap data). Subwatersheds with 0-19.5% risk scored -1 risk (n=57); 21-59.5% scored 0 (40); 64-96.4% scored 1 (45). Total score was obtained by adding risk to weighted (2x) priority (rare plant score + rare animal score). Subwatersheds outside the boundaries were excluded. High scores mean high risk and high priority.

PORE was ranked by Don Brown, GIS specialist at the time. Much of the work was already done, such as vegmap and fenceline data being put into Access, but exotics needed to be worked up and trails intersected (main roads and powerlines were present). Rare plant coverages needed to be included, but rare animals were done. Once the subwatersheds were ranked, the shapefile sub_watersheds2001 was updated (and its name changed to priors_suwa); the field SUB_SHED_D populated to reflect a score of High, Significant, Moderate, or Low priority. A layer was created with symbology outlining subwatersheds in black, with a colored line coding priority level inside (red, orange, yellow, or green; white for out of park), but the polygons otherwise hollow.

MANAGEMENT PRIORITY FACTOR: RARE SPECIES
Rare plants:
[inppore07]:\GIS\vector1\veg\rareplants\covers\pore_rare_plants_2006
[inppore07]:\GIS\vector1\veg\rareplants\covers\rare_plant_polygons
[gis on 'inpgogamahe1.nps.doi.net']:\Veg\Rare\Rare_2003\allrare_03
[gis on 'inpgogamahe1.nps.doi.net']:\Veg\T&E\Plants\rare_03
Clip rare plant layers to park boundary. If your rare plant data is all polygons, then you can just calculate the area in each watershed and add the data to the spreadsheet. If you have some rare plant data that is points, then buffer by 2 meters, merge with any polygon rare plant data then

calculate the areas per watershed.

Rare Animals from [gis on 'inpgogamahe1.nps.doi.net']:\Wildlife:

Cato1.shp	Eune1.shp	Isge2.shp	Onmy2.shp	Raau4.shp	
Cato2.shp	Eune2.shp	Luca1.shp	Raau1.shp	Raau5.shp	
Clma1.shp	Frogs83.shp	Onki1.shp	Raau2.shp	Rabo1.shp	
Clma2.shp	Isge1.shp	Onmy1.shp	Raau3.shp	Sypa1.shp	Thsi1.shp

Habitat data from northern spotted owl, Mission blue butterfly, and western snowy plover were also used. The merged files were imported into Access and summed; however it was quickly clear that repeated mapping of habitat produced gross overestimation of acreages (often several times that of the actual acres in the subwatershed). The number of rare animal taxa in a subwatershed was totaled and used as the ranking, so unlike the usual 1, 0, -1 ranks for this factor varied from 0 to 2 before final weighting.

RISK FACTOR: INFRASTRUCTURE
Infrastructure, compiled from PORE line shapefiles:
For Point Reyes we looked at the roads, fences, power lines, and trails.
[inppore07]:\GIS\vector1\trans\roads\covers\marin_roads
[inppore07]:\GIS\vector1\Cultural_Resources\Fences\gpsfences
[inppore07]:\GIS\vector1\facilities\powerlines_towers\powerlines
[inppore07]:\GIS\vector1\facilities\trails\covers\pore_trails

Infraline, compiled from GOGA polyline shapefiles:
coastal_trail.shp
Existing_trails. and fig3a.shp
goga_trails_s03.shp
goga_trails_s03.shp (last edited 2003)
headlands_trails.shp
lands_end_local_trails.shp
lands_end_social_trails.shp
milagra.shp (last edited 1999)
sweeney.shp (last edited 1999)

After they were clipped to the park boundary, line files were all buffered by four feet then merged together and split up by watershed. Then the area (in acres) was calculated per watershed and put into the spreadsheet.

Infrapoly, compiled from GOGA polygon shapefiles:
ggnra_structures
Multi_powerlines
Buffer_of_urban.

RISK FACTOR: VEGETATION TYPE
[inppore07]:\GIS\vector1\veg\vegmap\vegetation_1994

At-risk vegetation types (native superalliances that were not closed-canopy evergreen forest) taken from vegmap.

CURRENT INFESTATION FACTOR: EXOTIC VEGETATION
Exotic-dominated vegetation:
[inppore07]:\GIS\vector1\veg\vegmap\vegetation_1994
A vegetation layer (interpreted from aerial photos) for the whole park was clipped to the park boundary. It was then analyzed to determine areas that were exotic dominated (e.g., California exotic annual grassland or Eucalyptus). These areas were then split up by watershed and added to the spreadsheet.

Mapped exotic species populations:
Point Reyes exotics shapefiles are scattered around, but those used may be found in [inppore07]:\GIS\projects1\anwi\ED\dons_work. In general, the shapefiles had pretty good information about cape ivy, Scotch broom, French broom, panic veldt grass, pampas/jubata grass, eucalyptus, capeweed, and exotic spartina.All GPS'ed exotic plant location layers were clipped to park boundary. Point data were buffered by two meters and merged with any polygon exotic data. The area of mapped exotics in each watershed was calculated and added to the spreadsheet.

Exotic Plant layers for Golden Gate from [gis on 'inpgogamahe1.nps.doi.net']:\Veg\Invasive:

1995-pol.shp	clily_87.shp	cuma_98.dbf	fovu.dbf	Levuall_1997.shp
98ox-ey1.shp	coju.dbf	cysc.dbf	Fovu.shp	levuall_1999.dbf
acxx.shp	Coju_87.shp	Cysc_87.shp	fovu87.shp	lotus_87.shp
Acxx_1999.shp	Coju_d.shp	Cyscmahe.shp	French Broom Map	m_cyp87.shp
agad_87.shp	coju_k.dbf	deod_87.shp	fwy_daisy87.shp	milk_thistle87.s
agad_all_2002cli	Coju2.shp	deod_all02.dbf	Gemo_87.shp	mmwd_inv_87.shp
Agadfb_01.shp	coju87.shp	Deodteho.shp	gemo_all_2002_cl	mmwd_invbroom_87
agadmahe_2002.db	Coju99sh.shp	ecxx.dbf	gemo_d.dbf	mont_pine87.shp
axcc_all_2002_cl	Cojumahe.shp	Ecxxmahe.shp	Gemo_k.shp	Monterey Cypress
broom_87.shp	Cojumahe_2001.sh	Eng_ivy.shp	gemo87.shp	mustard87.shp
caed.dbf	Coma.shp	Euc_2000.shp	german_ivy.shp	night_shade87.sh
Caed.shp	Coma_87.shp	euc_98.dbf	gorse87.shp	nshade_87.shp
Caed_1999.shp	coma2shp.dbf	Eucalyptus.shp	hehe.dbf	p_hemlock87.shp
Caed_sb_082401.s	Comamahe.shp	Eugl.shp	Hehe.shp	Peri_87.shp
Caed-deod_sb_082	coxx.dbf	eugl87.shp	hehe87.shp	Pira_all_2002cli
calla_lily87.shp	Coxx.shp	eupatorium87.shp	Hepe_98.shp	Scotch_b87.shp
cape_87.shp	Coxx_87.shp	exotics-.dbf	Hepe_99.shp	Uleu_87.shp
capy_87.shp	coxx87.shp	Exotics-.shp	Inv_2000k.shp	Vima87
capy87.shp	Coxxmahe.shp	Fennel.shp	inv_all2000d.dbf	Water_hyacinth87
C-east_98.shp	Cuma.shp	flax_87.shp	Levu.shp	W-hya_87
ci_broom87.shp	Cuma_2000.shp	Fova_87.shp	Levu99sh.shp	

Hours of work performed on exotics:
Point Reyes hours of work performed was in a separate Access database ([inppore05]:_Databases\Vegetation\weeds) and needed to be matched up to a GIS layer by a patch code number. The hours of work performed was added to the GIS layer, the number of

hours was totaled, split up by watershed, then added to the spreadsheet. For GOGA, time is tracked and recorded by subwatershed location. Staff time was not ranked and broken up into quarters; instead, subwatersheds that were in the mid-range were given an additional point, for the reason similar to the invasives mapping.

Number of different exotic species in each watershed:
The same Access databases were mined to figure out how many different guilds were worked on in each watershed. Note that actual areas were not looked at for this procedure.

Future rankings will use updated layers, with the bulk of invasive species information coming from GeoWeed data collected over the interval between rankings.

Appendix C. Locations of Priority Subwatersheds and Annual Survey Schedule

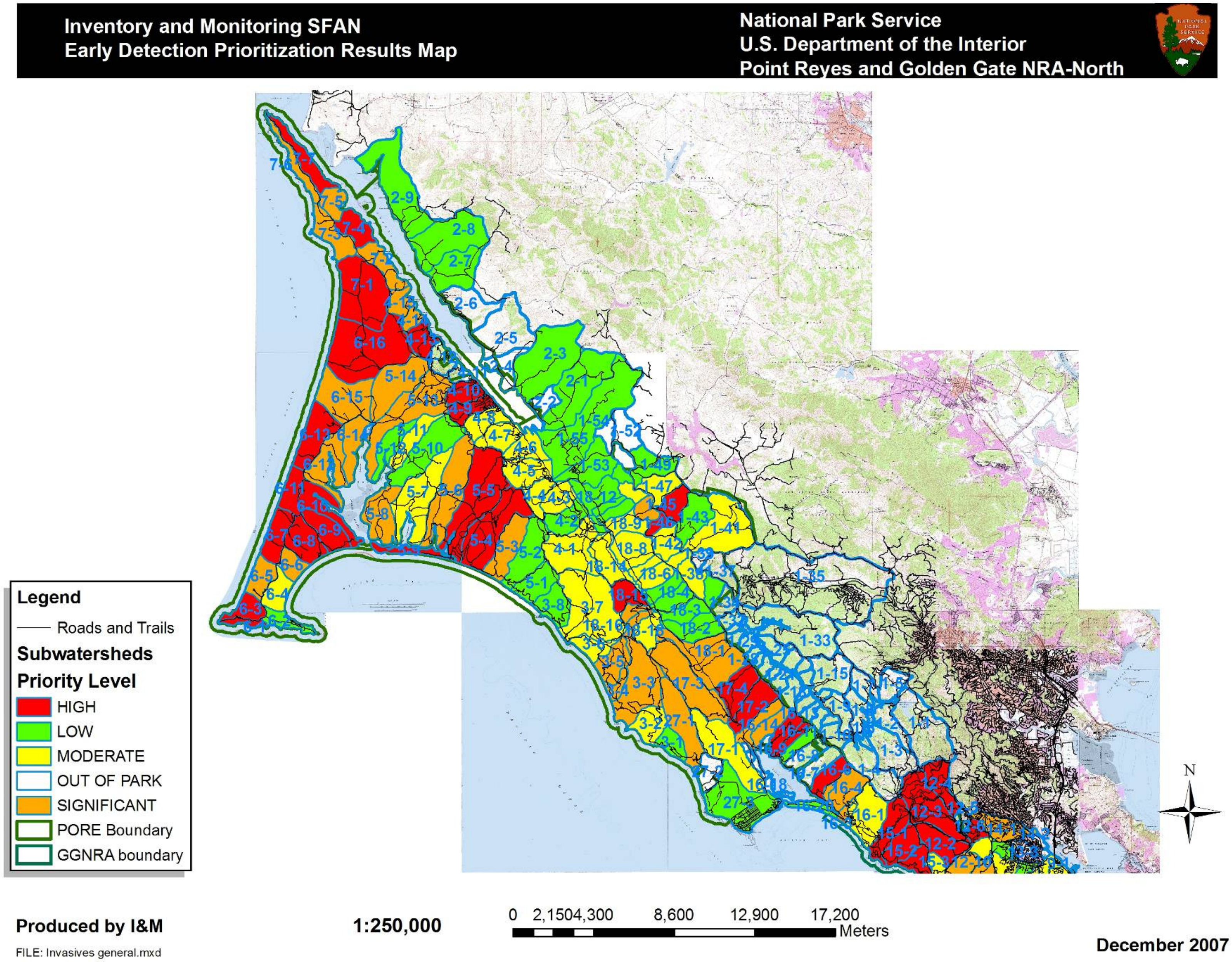

Figure 1. Map of prioritized subwatersheds in PORE and GOGA's northern lands.

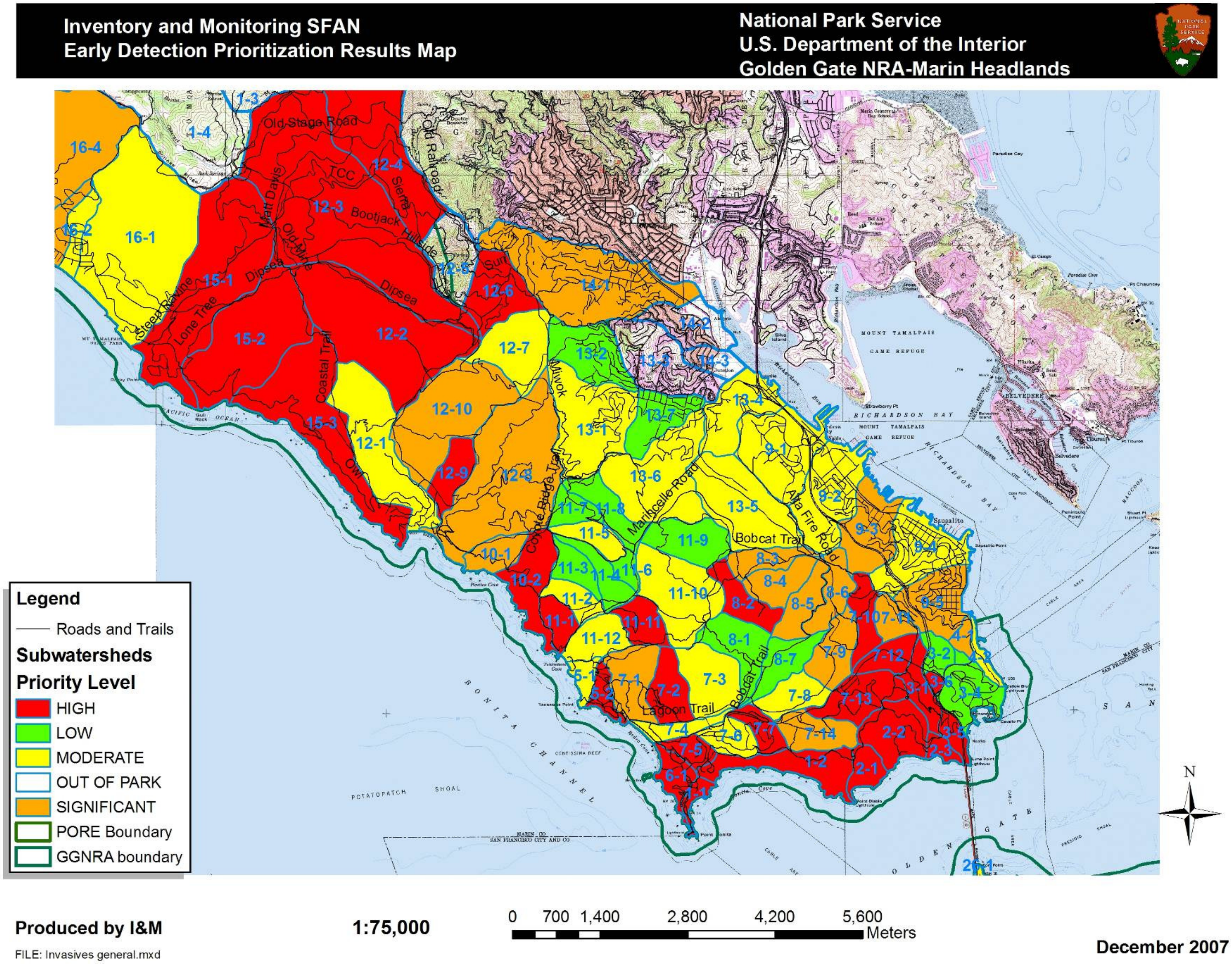

Figure 2. Map of prioritized subwatersheds in GOGA's Marin Headlands.

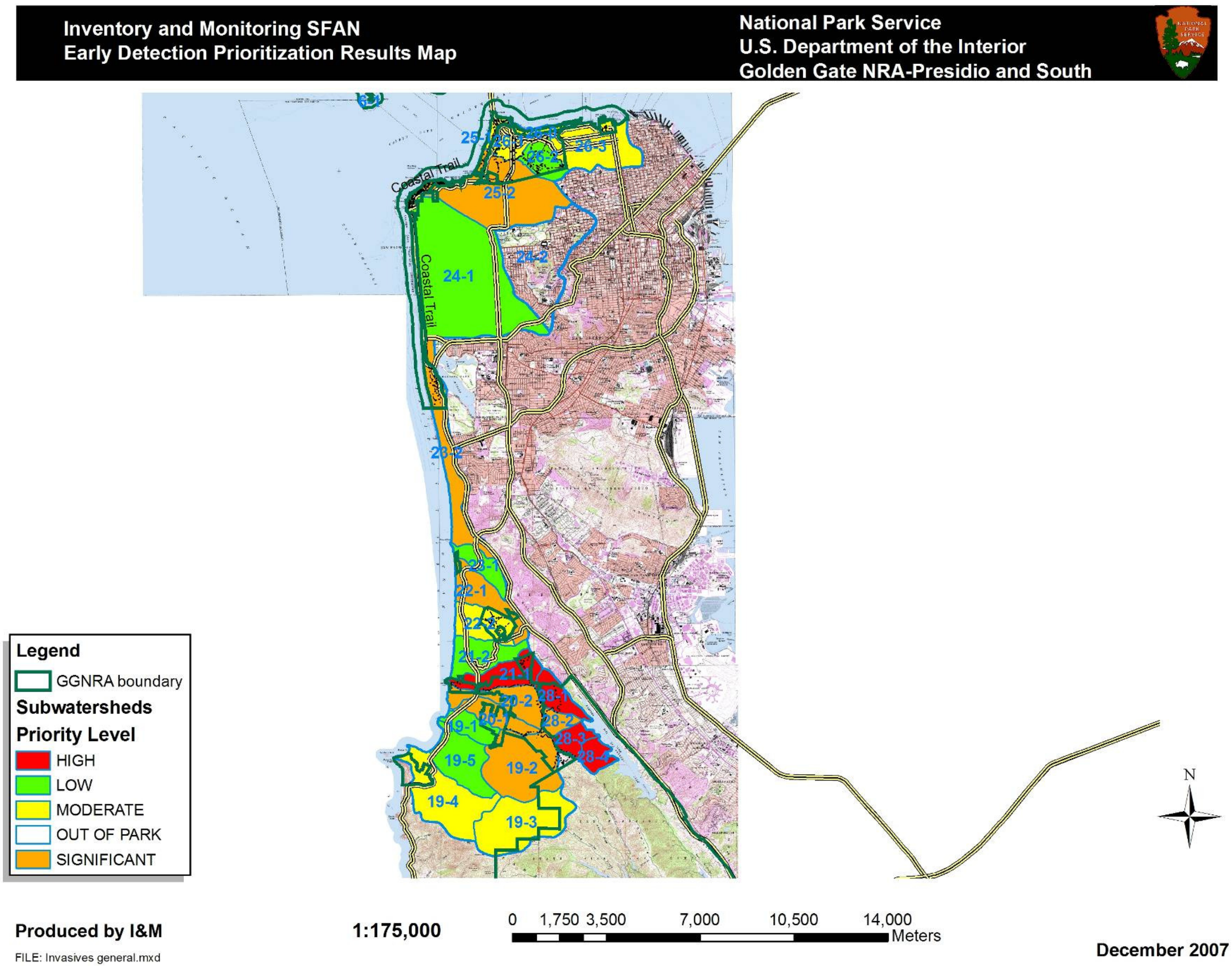

Figure 3. Map of prioritized subwatersheds in GOGA's southern lands.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE.

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA10-1		Significant	106.36		X		X	
	Coastal Fire Road			17-May	8-Apr			
	Coastal Trail			17-May	8-Apr			
	Social Trail			17-May	8-Apr			
GGNRA10-2		High	217.22	X	X	X	X	X
	Coastal Fire Road				8-Apr			
	Coastal Trail			17-May	8-Apr			
	Coyote Ridge Trail				8-Apr			
	Social Trail				8-Apr			
GGNRA1-1		High	38.69	X	X	X	X	X
	Check - Headlands Institute			10-Apr				
	Check - YMCA			10-Apr				
	Point Bonita Trail			10-Apr				
	Social Trail			10-Apr				
GGNRA11-11		High	116.69	X	X	X	X	X
	Hill 88			13-Aug	4-Jun			
	Coastal Trail			13-Aug	4-Jun			
	Wolf Ridge Trail			13-Aug	4-Jun			
GGNRA11-1		High	85.38	X	X	X		
	Coastal Trail			17-May				
	Tennessee Valley Trail			27-May				
GGNRA11-10		Moderate	349.48				X	
	Chapparal Trail (open part)							
	Miwok Trail							
	Old Springs Trail			8-May				
	Social Trail							
	Wolf Ridge Trail							

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA11-12		Moderate	138.11					X
	Social Trail							
	Tennessee Valley Trail			27-May				
GGNRA11-2		Moderate	91.65				X	
	Coastal Fire Road							
	Coastal Trail							
	Social Trail							
	Tennessee Valley (lower)			27-May				
	Tennessee Valley Trail			27-May				
	Tennessee Valley Trail (Upper)			27-May				
GGNRA11-3		Low	95.81		X			
	Coastal Fire Road				8-Aug			
	Coastal Trail							
	Tennessee Valley Trail (Upper)							
GGNRA11-4		Low	106.31	X				
	Fox Trail			30-Jul				
	Social Trail							
	Tennessee Valley (lower)			4-Aug				
	Tennessee Valley Trail			4-Aug				
	Tennessee Valley Trail (Upper)			4-Aug				
GGNRA11-5		Moderate	94.74					X
	Coastal Fire Road							
	Coyote Ridge Trail							
	Fox Trail							
	Haypress							
GGNRA11-6		Low	46.27				X	
	Fox Trail							
	Social Trail							
	Tennessee Valley							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Trail							
GGNRA11-7		Low	85.46				X	
	Coyote Ridge Trail							
	Green Gulch Trail							
	Haypress Camp Trail							
	Middle Green Gulch Trail							
	Social Trail							
GGNRA11-8		Low	140.52		X			
	Haypress Camp Trail			2-Apr	5-Jun			
	Social Trail (heads N near camp)			2-Apr				
	Tennessee Valley Trail			2-Apr	5-Jun			
GGNRA11-9		Low	193.47					X
	Marincello Road							
	Miwok Trail							
	Old Springs Trail			8-May				
	Bobcat Trail							
GGNRA1-2		High	229.19	X	X	X	X	X
	Black Sands Beach/Fisherman's Trail			28-Jul				
	Coastal Trail			28-Jul				
	Conzelman Road			19-Aug				
	Social Trail			28-Jul				
GGNRA12-1		Moderate	467.28					X
	Coastal Trail							
	Heather Cutoff							
	Hwy 1							
	Lagoon							
	Levee Rd							
	Muir Woods Road							
	Pacific							
	Seacape							
	Shoreline							
	Social Trail							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA12-10		Significant	528.62		X		X	
	Hwy 1							
	Social Trail ??							
	Redwood Creek Trail							
GGNRA12-2		High	808.31	X	X	X	X	X
	Ben Johnson Trail			16-Oct	27-May			
	Deer Park Fire Road			3/20, 10/16	27-May			
	Dipsea			3/20, 10/16	27-May			
	Muir Woods Road							
GGNRA12-3		High	1468.61	X	X	X	X	X
	Ben Johnson			16-Oct	27-May			
	Deer Park Fire Road			16-Oct	27-May			
	Dipsea			16-Oct	27-May			
	Hillside			21-Aug	27-May			
	Muir Woods Road							
	Main Trail			21-Aug				
	Stapelveldt			16-Oct	27-May			
GGNRA12-4*		High	712.15	X	X	X	X	X
	Camp Eastwood							
	Main Trail							
	Fern Creek							
	Ocean View							
GGNRA12-5		High	224.54	X	X	X	X	X
	Camp Eastwood							
	Fern Creek							
	Main Trail			21-Aug				
	Ocean View							
GGNRA12-6		High	239.81	X	X	X	X	X

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Dipsea Trail			20-Mar				
	Muir Woods Road							
GGNRA12-7*		Moderate	264.42				X	
	Camino del Canyon							
	Homestead Fire Road							
	Social Trail							
GGNRA12-8		Significant	837.66	X		X		X
	Coastal Fire Road			12-Sep				
	Coastal Trail			17-May				
	Coyote Ridge Trail			12-Sep				
	Dias Ridge			10-Aug	under construction/no access			
	Green Gulch Trail			12-Sep				
	Levee Road							
	Middle Green Gulch Trail			11-Aug				
	Miwok			19-Jun				
	Shoreline/ Hwy 1							
	Social Trail			19-Jun				
GGNRA12-9		High	130.58	X	X	X	X	X
	Dias Ridge			10-Aug	under construction/no access			
	Lagoon							
	Shoreline/Hwy 1							
GGNRA13-1		Moderate	435.65					X
	Coyote Ridge Trail			19-Jun				
	Hwy 1							
	Miwok Fire Road			23-Apr				
	Panoramic Highway							
	Social Trail			19-Jun				
GGNRA13-2		Low	242.76			X		
	Eastwood/Shoreline F							
	Homestead Fire Road							
	Lattie							
	Waterview							
	Social Trail							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA13-4		Moderate	244.89			X		
	Alta Fire Road							
GGNRA13-5		Moderate	418.99				X	
	Alta Fire Road							
	Bobcat Trail							
	Marincello Road							
	Miwok Trail							
	Oakwood Valley Trai (lower)							
	Oakwood Valley Trail							
	Orchard Rire Road							
	Rhubarb Trail							
	Social Trail							
	Tennessee Valley Road							
GGNRA13-6		Moderate	461.9	X				
	Marincello Road			29-Jul				
	Miwok Trail			25-Jul				
	Rhubarb Trail			31-Jul				
	Social Trail			2-Apr				
	Tennessee Valley Road							
GGNRA13-7		Low	176.66	X				
	County View Road			19-Jun				
GGNRA14-1		Significant	704.86		X		X	
	Lattie Homestead Fire Road							
	Waterview							
	Social Trail							
GGNRA15-1		High	849.6	X	X	X	X	X
	Dipsea Trail			7-May				
	Panoramic							
	Steep Ravine			7-May				
GGNRA15-		High	629.28	X	X	X	X	X

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
2*								
	Coastal Trail							
GGNRA15-3		High	640.21	X	X	X	X	X
	Coastal Trail							
	Muir Beach Overlook			3-Jul	12-Mar			
	Owl			3-Jul	12-Mar			
	Shoreline/Hwy 1							
GGNRA16-1		Moderate	1059.11	X				
	Dipsea			7-May				
	Shoreline/Hwy 1							
	Matt Davis Trail			7-May				
	Panoramic Highway							
GGNRA16-10		High	241.35	X	X	X	X	X
	Bolinas Fairfax Road							
GGNRA16-11		High	431.72	X	X	X	X	X
	Bolinas Fairfax Road							
	Bolinas Ridge							
GGNRA16-12		Significant	112.31		X		X	
	Bolinas Fairfax Road							
	Shoreline							
GGNRA16-13		Significant	427.18		X		X	
	Bolinas Fairfax Road							
	Bolinas Ridge							
	Shoreline							
GGNRA16-14		Significant	458.71		X		X	
	Bolinas Ridge							
	Mine Gulch							
	Shoreline							
GGNRA16-16		Low	312.66		X			
	Bolinas Fairfax							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Road							
	Bourne Fire							
GGNRA16-2		Moderate	91.91		X			
	Farralon Fire Road							
	Stinson Beach Federal Park							
	Willow Camp Fire Road							
GGNRA16-3		Significant	118.85	X		X		X
	Farralon Fire Road							
	Shoreline							
	Willow Camp Fire Road			6-Aug				
GGNRA16-4		Significant	682.56	X		X		X
	Farralon Fire Road							
	McKenna Gulch Fire Road			25-Sep				
	Shoreline							
GGNRA16-5		Significant	90.83		X		X	
	Farralon Fire Road							
	McKenna Gulch Fire Road							
	Shoreline							
GGNRA16-6		High	506.12	X	X	X	X	X
	Coastal Trail							
	Farralon Fire Road							
	McKenna Gulch Fire Road							
	Shoreline							
GGNRA16-7		High	505.3	X	X	X	X	X
	Coastal Trail							
	Shoreline							
GGNRA16-8		High	527.3	X	X	X	X	X
	Bolinas Fairfax Road							
	Bolinas Ridge							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Coastal Trail Shoreline							
GGNRA17-1		Moderate	1588.66			X		
	Pablo Point Ridge Stewart Point Access							
GGNRA17-2		High	799.39	X	X	X	X	X
	Bolinas Ridge McCurdy Trail Mine Gulch Shoreline Unnamed trail							
GGNRA17-3		Significant	1738.4	X		X		X
	Lake Ranch Olema Valley Pablo Point Ridge Shoreline Teixeira							
GGNRA17-4		High	840.96	X	X	X	X	X
	Bolinas Ridge McCurdy Trail Ragetti Shoreline Unnamed trail							
GGNRA18-1		Significant	1770.64		X		X	
	Bolinas Ridge Borello Olema Valley Ragetti Randall Randall Spur Shoreline							
GGNRA18-10		Low	295.72					X
	Shoreline							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA18-11		Low	180.27				X	
	Shoreline							
GGNRA18-12		Low	727.07		X			
	Shoreline							
	Sir Francis Drake Bl							
GGNRA18-13		Low	102.09	X				
	Bear Valley Road							
	Rift Zone							
GGNRA18-14		Moderate	805.59					X
	Rift Zone							
GGNRA18-15		High	537.38	X	X	X	X	X
	Access							
	Greenpicker							
	Rift Zone							
	Stewart							
GGNRA18-16		Significant	204.79	X		X		X
	Greenpicker							
	Horse Camp							
	Rift Zone							
	Stewart							
GGNRA18-17		Significant	157.77		X		X	
	Horse Camp							
	Rift Zone							
	Stewart							
GGNRA18-18		Moderate	490.03			X		
	Olema Valley							
	Ridge							
	Rift Zone							
	Shoreline							
	Stewart							
GGNRA18-2		Low	761.89				X	
	Bolinas Ridge							
	Shoreline							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA18-3		Low	493.2			X		
	Bolinas Ridge							
	Shoreline							
GGNRA18-4		Low	487.67			X		
	Bolinas Ridge							
	Horse Camp							
	Shoreline							
GGNRA18-5		Low	364.63	X				
	Access							
	Bolinas Ridge							
	Shoreline							
GGNRA18-6		Moderate	448.88		X			
	Bolinas Ridge							
	Shoreline							
GGNRA18-7		Moderate	244.16			X		
	Bolinas Ridge							
	Shoreline							
GGNRA18-8		Moderate	864.58				X	
	Bolinas Ridge							
	Shoreline							
GGNRA18-9		Moderate	497.98			X		
	Bear Valley Road							
	Bolinas Ridge							
	Shoreline							
	Sir Francis Drake Bl							
GGNRA19-1		Low	386.44		X			
	Baquiano Trail							
	Sweeny Ridge Rd							
GGNRA19-2		Significant	1512.61	X		X		X
	Baquiano Trail			14-Jul				
	Horse Trail			26-Aug				
	Sweeney Ridge			26-Aug				

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Trail							
	Social Trail			26-Aug				
GGNRA19-3		Moderate	1410.73	X				
	no roads or trails							
GGNRA19-4			Out of park					
GGNRA19-5*		Low	889.23				X	
	no roads or trails							
GGNRA20-1		Significant	467.16	X		X		X
	Baquiano Trail			14-Jul				
	Sweeny Ridge Rd							
GGNRA20-2		Significant	688.8		X		X	
	Baquiano Trail			14-Jul				
	Bluff Trail			28-Oct	25-Apr			
	CA Coastal Trail			28-Oct	25-Apr			
	Mori Ridge Trail			25-Oct	19-Mar			
	Nike Site			14-Jul				
	Notch Trail			28-Oct	25-Apr			
	Peak Trail			28-Oct	25-Apr			
	Sneath Lane			26-Aug				
	Sneath Lane Fire Rd			26-Aug				
	Sweeney Ridge Trail							
	Tmigtac Trail			28-Oct	25-Apr			
	Unnamed trail			28-Oct	25-Apr			
	water tank access			25-Oct	25-Apr			
	Wildflower Way			28-Oct	25-Apr			
GGNRA2-1		High	80.51	X	X	X	X	X
	Conzelman Road			26-Aug				
	Social Trail			24-Oct				
GGNRA21-1		High	661.09	X	X	X	X	X
	Berm Trail			28-Oct	25-Apr			
	Bluff Trail			28-Oct	25-Apr			
	Bootlegger's Steps			28-Oct	25-Apr			
	Coastal Trail			28-Oct	25-Apr			
	Lishumsha Loop			28-Oct	25-Apr			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Mori Point Rd			28-Oct	25-Apr			
	Mori Ridge Trail			28-Oct	25-Apr			
	Mori Spring Trail			28-Oct	25-Apr			
	Notch Trail			28-Oct	25-Apr			
	Peak Trail			28-Oct	25-Apr			
	Sweeney Ridge Trail			30-Sep	19-May			
GGNRA21-2		Low	679.54					X
	Berm Trail							
GGNRA2-2		High	212.09	X	X	X	X	X
	Conzelman Road			24-Oct	13-Apr			
	Kirby Cove Road			10-Jul	23-Apr			
	Kirby Cove Spur Trail 1			10-Jul	23-Apr			
	Kirby Cove Spur Trail 2			10-Jul	23-Apr			
	Kirby Cove Spur Trail 3			10-Jul	23-Apr			
	McCullough Road			24-Jul				
	Slacker Hill Fire Road			24-Jul	13-Apr			
	Social Trail			24-Oct				
GGNRA22-1		Significant	696.13	X		X		X
	no roads or trails							
GGNRA22-2		Moderate	634.22			X		
	Milagra Ridge Trail							
	Milagra Trail							
	Unnamed trail							
GGNRA2-3		High	41.03	X	X	X	X	X
	Battery Spencer Trail			5-May				
	Conzelman Road			24-Oct	13-Apr			
	Kirby Cove Road			10-Jul	23-Apr			
	Kirby Cove Spur Trail 1			10-Jul	23-Apr			
GGNRA23-1		Low	384.83			X		
	no roads or trails							
GGNRA23-		Significant	1060.83	X		X		X

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
2								
	Chip Trail			14-Aug				
	Coastal Trail			14-Aug				
	Horse Trail			14-Aug				
GGNRA24-1		Low	4192.35					X
	48th to Sutro Loop Trail							
	Balboa Staircase							
	Cliff House							
	Coastal Trail							
	Coastal/Lands End Trail							
	Ocean Terrace Connector							
	Social Trail							
	Sutro Baths Staircase							
	Sutro Baths Trail							
	Sutro Baths Upper Trail							
	Sutro Heights Loop Trail							
	Sutro Ruins Cutoff Trail							
	Sutro Ruins Trail							
GGNRA25-1		Moderate	107.95				X	
	Batteries to Bluffs Trail							
	Bay Area Ridge Trail							
	Coastal Trail							
	Coastal/SF Bay Trail							
GGNRA25-2		Significant	2242.41	X		X		X
	Anza Trail							
	Anza/Mtn Lake Trail							
	Battery Crosby Trail							
	Bay Area Ridge Trail							
	Coastal/Lands End			8-Oct				

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Trail							
	El Camino del Mar			8-Oct				
	Social Trails			8-Oct				
GGNRA26-0		Moderate	162.47	X				
	Airstrip Trail							
	AmphitheaterTrail							
	Chestnut Walk							
	Crissy Field Promenade							
	East Beach Berm Trail							
	East Beach Boardwalk							
	East Beach Lagoon Trail							
	East Beach Picnic Trail							
	East Crissy Trail							
	Haus Plaque Boardwalk							
	Mason Street Bike Path							
	Park Boulevard							
	Promenade Cut-off Trail							
	Tennessee Hollow							
	Unnamed trail							
	West Bluff Cut-off Trail							
	West Bluff Picnic Area Trail							
GGNRA26-1		Moderate	318.68					X
	Admin. Trail							
	Andrews Road							
	Battery East Trail							
	Bay Area Ridge Trail							
	Cemetery Connector							
	Cemetery Overlook							
	Coastal/SF Bay							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Trail							
	Compton Road Connector							
	Crissy Field Promenade							
	Dragonfly Crreek							
	Long Avenue							
	Park Boulevard							
	Presidio Promenade							
	Storey Avenue Connector							
	Terrace to Post							
GGNRA26-2		Low	445.95					X
	Anza Esplanade							
	Bay Area Ridge Trail							
	Cemetery Link East connector							
	Cemetery Overlook							
	Chestnut Walk							
	Ecology Trail							
	Lovers Lane							
	Mountain Lake							
	Mountain Lake/Presidio Blvd							
	Oak-Redwood							
	Presidio Boulevard							
	Presidio Boulevard Connector							
	Presidio Promenade							
	Tennessee Hollow Trail							
	Terrace to Post							
	Unnamed trail							
	West Pacific							
GGNRA26-3		Moderate	1185.25				X	
	Chestnut Walk							
	Great Meadow Paths							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Great Meadow to LFM Staircase							
	Mountain Lake							
	Presidio Boulevard							
	Presidio Boulevard Connector							
	Presidio Promenade							
	San Francisco Bay Trail							
	Staircase McDowell to Parade Ground							
	West Pacific							
GGNRA27-1		Significant	1244.42	X		X		X
	Coast							
	Lake Ranch							
	Mesa							
	Point Reyes Bird Obs							
	Ridge							
GGNRA27-2		Low	528.39				X	
	Duxbury Reef							
	MCI Access							
	Mesa							
	Ridge							
	Stewart Point Access							
	Unnamed trail							
GGNRA27-3		Low	1826.33	X				
	Gaspers							
	Ivy							
	Locust							
	MCI Access							
	Mesa							
	Poplar							
	Purple Gate							
	Stewart Point Access							
	Tulip							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Unnamed trail							
	Vine							
	Walnut							
	Zebra							
GGNRA28-1		High	414.56	X	X	X	X	X
	Nike Site			14-Jul				
	Sneath Lane			22-May				
	Sneath Lane Fire Rd			22-May				
	Sweeney Ridge Trail			26-Aug				
GGNRA28-2		Significant	213.53		X		X	
	Sneath Lane							
	Sweeney Ridge Trail							
	utility access							
GGNRA28-3		High	286.48	X	X	X	X	X
	PORTOLA RD			26-Aug				
GGNRA28-4*		High	278.52	X	X	X	X	X
	PORTOLA RD							
GGNRA3-1		High	105.27	X	X	X	X	X
	Bunker Road			15-Sep				
	Coastal Trail			17-Jul	26-Mar			
	Conzelman Road			24-Oct	13-Apr			
	SCA Trail			17-Jul	13-Apr			
	Slacker Hill Fire Road			17-Jul	13-Apr			
GGNRA3-2		Low	67.49			X		
	Bunker Road			15-Sep				
	Hwy 101							
	Sausalito-Lateral							
GGNRA3-3		Low	11.37				X	
	Sausalito-Lateral							
GGNRA3-4		Low	178.67		X			
	Battery Yates Trail							
	Bay Trail							
	Bunker Road							
	Chapel Steps Trail							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Coastal Trail							
	Conzelman Road							
	Drown Fire Road							
	East							
	Hwy 101							
	Kober							
	McReynolds							
	Merrill							
	Murray							
	Sausalito-Lateral							
	Seitler							
	Sommerville							
	Swain							
	Umia							
	Unnamed trail							
	Vista Point							
GGNRA3-5		High	53.4	X	X	X	X	X
	Battery Spencer Trail			5-May				
	Coastal Trail			17-Jul	13-Apr			
	Conzelman Road			24-Oct	13-Apr			
	Old Conzelman Road			17-Jul	13-Apr			
GGNRA3-6		High	18.58	X	X	X	X	X
	Bunker Road							
	Hwy 101							
	Sausalito Lateral							
GGNRA4-1		Significant	37.23	X		X		X
	Alexander Road							
	Bay Trail							
	East							
	Sausalito-Lateral							
GGNRA4-2		Moderate	39.09				X	
	Bay Trail							
	East							
	Sausalito-Lateral							
GGNRA5-1		Moderate	54.85			X		
	Mitchell Road							
	Social Trail							
GGNRA5-2		High	63.57	X	X	X	X	X
	Coastal Fire			24-Jul				

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Coastal Trail			24-Jul				
	Mitchell Road			24-Jul				
	Social Trail			24-Jul				
GGNRA6-1		High	94.47	X	X	X	X	X
	Battery Alexander/S Rodeo Beach Trail			16-Apr				
	Battery Smith-Guthrie Trail			16-Apr				
	Conzelman			26-Aug				
	Pacific Coast Trail			16-Apr				
	Point Bonita Trail			16-Apr				
	Social Trail			16-Apr				
GGNRA7-1		Significant	195.27	X		X		X
	Check - Headlands Institute			12-Aug				
	Coastal/Old Bunker Fire Road			28-Jun				
	Hill 88			12-Aug				
	Mitchell Road			15-Sep				
	Social Trail			12-Aug				
	Wolf Ridge Trail			12-Aug				
GGNRA7-10		High	117.35	X	X	X	X	X
	Alta Avenue Fire Road			16-May				
	Morning Sun Trail			16-May				
	Rodeo Valley Fire Road			16-May				
	SCA Trail			16-May				
GGNRA7-11		Significant	83.23		X		X	
	SCA Trail							
	Wolfback							
GGNRA7-12		High	99.44	X	X	X	X	X
	Bunker Road			15-Sep				
	Coastal Trail			21-Jul	13-Apr			
	SCA Trail			21-Jul	13-Apr			
GGNRA7-13		High	195.27	X	X	X	X	X
	Bunker Road			15-Sep				
	Coastal Trail			21-Jul	13-Apr			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	McCullough Road			21-Jul				
	Slacker Hill Fire Road			21-Jul	13-Apr			
	Social Trails			21-Jul				
GGNRA7-14		Significant	156.52	X		X		X
	Bunker Road			15-Sep				
	Coastal Trail			23-Jul				
	Social Trail			23-Jul				
GGNRA7-2		High	152.06	X	X	X	X	X
	Bunker Road			15-Sep				
	Coastal/Old Bunker Fire Road			28-Jun				
	Fort Cronkhite			12-Aug				
	Hill 88			12-Aug				
	Lagoon Trail			15-Sep				
	Mitchell			15-Sep				
	Social Trail			12-Aug				
GGNRA7-3		Moderate	226.28					X
	Bunker Road			15-Sep				
	Coastal Trail							
	Lagoon Trail							
	Miwok Trail							
	Social Trail							
GGNRA7-4		Moderate	77.92				X	
	Bunker Road			15-Sep				
	Coastal Trail							
	Lagoon Trail							
	Miwok							
	Pacific Coast Trail							
	Social Trail							
GGNRA7-5		High	71.41	X	X	X	X	X
	Battery Smith-Guthrie Trail			10-Apr				
	Coastal/Lagoon Trail			10-Apr				
	Conzelman Road			10-Apr				
	Social Trail			10-Apr				
GGNRA7-6		Moderate	103.67		X			
	Bodsworth							
	Bunker Road							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Coastal Trail							
	Conzelman Road							
	Field							
	Fire Road							
	Lagoon Trail							
	Rosenstock							
	Simmonds							
	Social Trail							
GGNRA7-7		High	89.34	X	X	X	X	X
	Bunker Road			15-Sep				
	Coastal Trail			2-Sep				
	Conzelman Road			26-Aug				
	Gerbode Trail			12-Aug				
	Simmonds			15-Sep				
	Social Trail			2-Sep				
GGNRA7-8		Moderate	130.65			X		
	Bay Area Ridge Trail							
	Bunker Road							
	Rodeo Valley Fire Road							
GGNRA7-9		Significant	163.52		X		X	
	Rodeo Valley Cut-Off Trail							
	Rodeo Valley Fire Road							
	Social Trail							
GGNRA8-1		Low	195.21					X
	Bobcat Trail							
	Gerbode Trail							
	Miwok Trail							
	Social Trail							
	Wolf Ridge Trail							
GGNRA8-2		High	133.25	X	X	X	X	X
	Miwok Trail			29-Jul				
	Social Trail			29-Jul				
GGNRA8-3		Significant	107.49		X		X	
	Alta Avenue Fire Road							
	Bobcat/Miwok Trail							
	Hawk Camp Fire							

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Road							
	Rodeo Ave							
	Social Trail							
GGNRA8-4		Significant	135	X		X		X
	Alta Avenue Fire Road			2-Jul				
	Bobcat Trail			2-Jul				
GGNRA8-5		Significant	128.88		X		X	
	Alta Avenue Fire Road							
	Bobcat Trail							
	Rodeo Ave							
GGNRA8-6		Significant	132.17	X		X		X
	Alta Avenue Fire Road			2-Jul				
	Bobcat Trail			20-Aug				
	Rodeo Ave			2-Jul				
	Rodeo Valley Cutoff			9-Aug				
GGNRA8-7		Low	142.78				X	
	Bobcat Trail							
	Gerbode Trail							
	Miwok Trail							
	Rodeo Valley Fire Road							
GGNRA9-1		Moderate	365.77				X	
	Alta Fire Road							
	Orchard Rire Road							
	Pacheco Fire Road							
GGNRA9-2		Moderate	339.57					X
	Alta Avenue Fire Road							
	Alta Fire Road							
	Oakwood Valley Trail							
	Orchard Fire Road							
	Rodeo Avenue Fire Road							
GGNRA9-3		Significant	247.4	X		X		X
	Alta Avenue Fire Road			16-May				
	Rodeo Avenue Fire Road			16-May				

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
GGNRA9-4		Moderate	296.15					X
	Alta Avenue Fire Road							
	Morning Sun Trail							
	Sundial							
	Wolfback Ridge							
GGNRA9-5		Significant	229.56		X		X	
	Cloud View							
	Hecht							
	US 101							
PORE1-10		Out of park	3.14					
	Coastal Trail							
PORE1-10			Out of park					
	Bolinas Ridge		28.6					
	Mine Gulch							
PORE1-21		Out of park	17.92					
	Bolinas Ridge							
PORE1-23		Out of park	11.92					
	Bolinas Ridge							
PORE1-24		Out of park	14.85					
	Bolinas Ridge							
	McCurdy Trail							
PORE1-26		Out of park	5.38					
	Bolinas Ridge							
PORE1-27		Out of park	14.82					
	Bolinas Ridge							
PORE1-28		Out of park	9.02					
	Bolinas Ridge				26-Aug			
PORE1-30		Out of park	21.24					
	Bolinas Ridge							
	Borello							
PORE1-32		Out of park	7.04					
	Bolinas Ridge							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Shafter							
PORE1-34		Out of park	36.17					
	Bolinas Ridge							
PORE1-36		Low	315.19	X				
	Bolinas Ridge							
PORE1-38		Moderate	481.86		X			
	Bolinas Ridge				10-Aug			
PORE1-40		Moderate	155.21	X				
	Bolinas Ridge			10-Sep				
PORE1-41		Moderate	1740.88	X				
	Devils Gulch Fire							
PORE1-42		Moderate	505.34		X			
	Bolinas Ridge			10-Sep	14-Jul			
	Cross Marin				14-Jul			
	Jewell				14-Jul			
	Taylor Park							
PORE1-43		Low	838.45		X			
	Cheda Ranch				1-Jul			
	Sir Francis Drake Bl				1-Jul			
PORE1-44		High	224.74	X	X	X	X	X
	Bolinas Ridge			10-Sep	14-Jul			
	Cross Marin			13-Sep	14-Jul			
	Taylor Park				1-Jul			
PORE1-45		High	500.57	X	X	X	X	X
	Sir Francis Drake Bl				1-Jul			
PORE1-46		Significant	305.77		X		X	
	Bolinas Ridge			10-Sep	14-Jul			
	Cross Marin			28-May	14-Jul			
	Sir Francis Drake Bl			13-Sep	14-Jul			
	Taylor Park				1-Jul			
	Unnamed trails				14-Jul			
PORE1-47		Moderate	593.26		X			
	Platform Bridge Road				31-Jul			
	Sir Francis Drake Bl				31-Jul			
PORE1-49		Low	748.99		X			
	Dam				31-Jul			
	Platform Bridge				31-Jul			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Road							
	Pt. Reyes Petaluma R				31-Jul			
PORE1-48		Moderate	241.91		X			
	no roads or trails							
PORE1-50		Low	175.34			X		
	no roads or trails							
PORE1-53		Low	1016.36			X		
	6th							
	Sir Francis Drake Bl							
	Shoreline							
	Tomales Bay							
PORE1-55		Low	2914.34				X	
	Shoreline							
	Tomales Bay							
PORE2-1		Low	1962.24				X	
	Shoreline							
PORE2-3		Low	2364.76					X
	Grand Canyon							
PORE2-7		Low	1116.63			X		
	Shoreline							
PORE2-8		Low	1823.55					X
	no roads or trails							
PORE2-9		Low	2137.02		X			
	Unnamed trail				19-Jun			
PORE3-1		Low	417.16	X				
	Coast Trail			18-Aug				
	Palomarin			18-Aug				
PORE3-2		Moderate	663.11					X
	Bass Lake							
	Coast Trail							
	Lake Ranch							
PORE3-3		Significant	1812.74	X		X		X
	Alamea							
	Alamere Falls			18-Aug				
	Coast Trail			18-Aug				
	Crystal Lake							
	Lake Ranch							
	Ridge			16-Sep				

* The boundary layers for this subwatershed are unclear; on-the-ground reconnaisance indicate some or all of this subwatershed is out of the park.

Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Stewart			16-Sep				
PORE3-4		Significant	247.34	X		X		X
	Coast Trail							
	Ocean Lake Loop							
	Old Out Road							
PORE3-5		Significant	682.83	X		X		X
	Alamea							
	Coast Trail							
	Glen							
	Greenpicker							
	Ocean Lake Loop			30-Oct				
	Old Out Road							
	Stewart							
PORE3-6		Moderate	457.69	X				
	Coast Glen Spur							
	Coast Glen Spur North							
	Coast Trail							
	Glen							
	Greenpicker							
PORE3-7		Moderate	2412.29		X			
	Arch Rock							
	Baldy				2-Jun			
	Bear Valley				2-Jun			
	Coast Glen Spur				18-Aug			
	Coast Glen Spur North				18-Aug			
	Coast Trail							
	Glen							
	Glen Camp Loop				18-Aug			
	Greenpicker				11-Aug			
	Old Pine				8-Jul			
	Ridge				8-Jul			
	Sky				2-Jun			
	Stewart				8-Jul			
	Unnamed trail				2-Jun			
PORE3-8		Low	698.57					X
	Baldy				2-Jun			
	Coast Trail				2-Jun			
	Kelham Beach				2-Jun			
	Sky				2-Jun			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
PORE4-1		Moderate	1447		X			
	Bear Valley				24-Jun			
	Bear Valley Road				24-Jun			
	Earthquake				8-Aug			
	Kule Loklo				30-Jun			
	Meadow				23-Jun			
	Morgan				18-Jul			
	Mt Wittenberg				4-Jun			
	Old Pine				9-Jul			
	Rift Zone				20-Jun			
	Sky				16-Jun			
	Wittenberg Summit				4-Jun			
	Woodard Valley				9-Jul			
	Woodpecker				6-Jul			
PORE4-10		High	493.91	X	X	X	X	X
	Pine Ridge				12-May			
PORE4-13		High	530.32	X	X	X	X	X
	Duck Cove				29-Jul			
PORE4-14		Significant	242.45	X		X		X
	Duck Cove							
	Sacramento Landing							
PORE4-15		Significant	397.97	X		X		X
	Marshall Beach				7-Jul			
	Sacramento Landing				29-Jul			
PORE4-2		Low	644.57	X				
	Bear Valley Road			4-Sep				
	Horse			28-Aug				
	Kule Loklo			9-Oct				
	Limantour							
	Morgan			9-Oct				
	Mt Wittenberg							
	Wittenberg Summit							
PORE4-3		Moderate	582.16				X	
	Bear Valley Road							
	Fox							
	Horse							
	Limantour							
	Silver Hills							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Sir Francis Drake Bl							
PORE4-4		Moderate	478.47					X
	Fire Lane							
	Horse							
	Limantour							
	Silver Hills							
	Sky							
	Z Ranch							
PORE4-5		Moderate	821.35	X				
	Douglas							
	Dover							
	Drakes Summit							
	Inverness Ridge							
	Sir Francis Drake Bl							
	Sunnyside							
PORE4-6		Moderate	592.97		X			
	Inverness Ridge				28-May			
	Kyleswood				1-Jul			
	Sir Francis Drake Bl				1-Jul			
PORE4-7		Moderate	651.92			X		
	Bucklin							
	Drakes View							
	Inverness Ridge							
	Mt Vision							
PORE4-8		Moderate	577.47	X				
	no roads or trails							
PORE4-9		High	516.38	X	X	X	X	X
	Vision				12-May			
PORE5-1		Low	733.79	X				
	Coast Trail							
	Old Pine							
	Sculptured Beach							
	Sky							
	Woodard Valley			10-Oct				
PORE5-10		Low	1447.28	X				
	Estero			15-Oct				
	Mt Vision			21-Aug				
PORE5-11		Moderate	618.47			X		
	Estero							

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Mt Vision							
PORE5-12		Low	614.17				X	
	Estero							
PORE5-13		Significant	1949.92		X		X	
	Mt Vision				12-May			
	Pierce Point Road				15-Jul			
	Pine Ridge				15-Jul			
	Sir Francis Drake Bl				15-Jul			
	Via de la Vista				15-Jul			
	Vision				12-May			
PORE5-14		Significant	1416.23	X		X		X
	Marshall Beach							
	Pierce Point Road							
	Sir Francis Drake Bl							
PORE5-2		Low	1121.51		X			
	Coast Trail				3-Aug			
	Fire Lane				22-May			
	Horse				4-Aug			
	Mt Wittenberg				4-Jun			
	Sky				17-Jun			
	Water				3-Aug			
	Wittenberg				4-Jun			
	Wittenberg Summit				4-Jun			
	Woodard Valley				9-Jul			
	Z Ranch				17-Jul			
PORE5-3		Significant	999.6		X		X	
	Coast Trail			18-Sep	3-Aug			
	Fire Lane				22-May			
PORE5-4		High	1805.94	X	X	X	X	X
	Bayview			8-Sep	17-Jun			
	Beach Access			18-Sep	10-Jun			
	Coast Trail			18-Sep	10-Jun			
	Education Center				21-Aug			
	Fire Lane			29-Aug	15-Jul			
	Hidden Valley				21-Aug			
	Laguna			31-Jul	24-Jul			
	Leeward				21-Aug			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Limantour				30-Jun			
	Sky			8-Sep	16-Jun			
	Sunset Overlook				21-Aug			
PORE5-5		High	2289.18	X	X	X	X	X
	Bayview			11-Jul	28-May			
	Beach Access				30-Jun			
	Bucklin			5-Aug	30-Jul			
	Drakes View			11-Jul	28-May			
	Education Center				21-Aug			
	Ensign				21-Aug			
	Estero				9-Jun			
	Inverness Ridge			11-Jul	28-May			
	Leeward				21-Aug			
	Limantour				30-Jun			
	Muddy Hollow			5-Aug	5-Aug			
	Muddy Hollow Road			24-Jul	29-May			
	Sunset Overlook				21-Aug			
PORE5-6		Significant	1791.24		X		X	
	Bucklin				30-Jul			
	Estero				9-Jun			
	Glenbrook				29-May			
	Muddy Hollow				29-May			
	Muddy Hollow Road				29-May			
PORE5-7		Moderate	1741.57		X			
	Drakes Head				19-Jun			
	Estero				19-Jun			
	Glenbrook				29-May			
	Muddy Hollow				29-May			
	Ramble				29-May			
	White Gate				29-May			
PORE5-8		Significant	1032.66		X		X	

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Estero				2-Jul			
	Sunset Beach				2-Jul			
PORE5-9		High	332.27	X	X	X	X	X
	Beach Access				30-Jun			
	Limantour				30-Jun			
	Limantour Spit			12-Aug	30-Jun			
PORE6-1		High	174.69	X	X	X	X	X
	Lighthouse				5-Jun			
	Overlook trail				5-Jun			
	Sea Lion Overlook				5-Jun			
	South Beach Overlook				5-Jun			
PORE6-10		High	828.6	X	X	X	X	X
	Drakes Beach				17-Jul			
	Sir Francis Drake Bl				17-Jul			
	Unnamed trail				17-Jul			
PORE6-11		High	535.09	X	X	X	X	X
	Drakes Beach			22-Jul	17-Jul			
	Sir Francis Drake Bl				17-Jul			
PORE6-12		Significant	1098.22		X		X	
	Bullpoint				27-Jun			
	Sir Francis Drake Bl				17-Jul			
PORE6-13		High	1062.29	X	X	X	X	X
	Sir Francis Drake Bl			7-Oct	17-Jul			
PORE6-14		Significant	695.05	X		X		X
	Sir Francis Drake Bl							
	Unnamed trail							
PORE6-15		Significant	1451.77	X		X		X
	Sir Francis Drake Bl			27-Oct				
	Unnamed trail							
PORE6-16		High	2838.31	X	X	X	X	X
	Abbotts Lagoon			22-Oct	22-Apr			
	Duck Cove				22-Apr			
	Marshall Beach				7-Jul			
	Pierce Point Road				22-Jul			
PORE6-2		Low	383.67		X	X		
	Chimney Rock				5-Jun			
	Elephant Seal Overlook				5-Jun			
	Lighthouse				5-Jun			
	Sir Francis Drake Bl				5-Jun			

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Sunset Beach Overlook				5-Jun			
PORE6-3		High	473.65	X	X	X	X	X
	Lighthouse			13-Sep	5-Jun			
	Sir Francis Drake Bl			12-Sep	5-Jun			
	South Beach Overlook			12-Sep	5-Jun			
PORE6-4		Moderate	565.01			X		
	Sir Francis Drake Bl							
	Unnamed trail							
PORE6-5		Significant	565.24	X		X		X
	Sir Francis Drake Bl							
PORE6-6		Significant	413.19		X		X	
	Sir Francis Drake Bl				17-Jul			
PORE6-7		High	723.39	X	X	X	X	X
	Sir Francis Drake Bl			28-Oct	17-Jul			
	Unnamed trail			28-Oct	17-Jul			
PORE6-8		High	876.12	X	X	X	X	X
	Peter Behr Overlook			17-Sep	17-Jul			
	Sir Francis Drake Bl			17-Sep	17-Jul			
PORE6-9		High	749.13	X	X	X	X	X
	Drakes Beach				17-Jul			
PORE7-1		High	2072.53	X	X	X	X	X
	Kehoe Beach			3-Sep	22-Jul			
	Marshall Beach				7-Jul			
	Pierce Point Road			7-Oct	22-Jul			
PORE7-2		Significant	655.75		X		X	
	Marshall Beach				7-Jul			
	Pierce Point Road				22-Jul			
PORE7-3		Significant	772.41		X		X	
	McClures Beach				24-Aug			
	Pierce Point Road				24-Aug			
	Tomales Point				9-May			
PORE7-4		High	616.57	X	X	X	X	X
	Pierce Point Road				24-Aug			
PORE7-5		Significant	436.28		X		X	
	Tomales Point				9-May			
PORE7-6		Significant	462.42		X		X	
	Tomales Point				9-May			
PORE7-7		High	697.14	X	X	X	X	X

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Table 1. Trails by subwatershed, and survey dates (planned or actual) for GOGA and PORE (continued).

Sub-watershed	Road/Trail Name	Priority	Sub-watershed Acres	2008	2009	2010	2011	2012
	Tomales Point				9-May			

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GOGA Trailhead Directions

Marin Headlands

Dias Ridge Trail

Trailhead about ½ a mile west of the Zen Center along Highway 1.
Directions: From Highway 101 in Marin County, take the Highway 1/Shoreline Highway exit. Continue along Highway 1 for about 5 miles to the trail head turn-off. If you pass the Muir Beach Turn-off, you have gone too far.

Kirby Cove

Battery Spencer parking lot
Directions: From San Francisco: Take Hwy 101north across the Golden Gate Bridge, Take the Alexander Avenue exit and curve left. Turn left at the stop sign and drive under the freeway overpass. From Hwy 101 South, take the 2nd Sausalito exit before the Golden Gate Bridge and turn left at the stop sign. From both directions: Do not get back onto 101, but veer to the right up the steep hill. This is Conzelman Road. The entrance to Kirby Cove will be on your left, a few hundred yards up Conzelman Road. Look for a gravel service road and metal gate, located at the end of the viewing point pullout.

Miwok Trail from Shoreline Hwy (Hwy 1)

Meet at the Miwok Trailhead
Directions: From Highway 101 in Marin County, take the Highway 1/Shoreline Highway exit. Continue to follow Highway 1/Shoreline Highway for about 3.5 miles and you will see the trailhead on the left, about ½ mile past the turn for Panoramic highway. There is parking in the pullout on the left at the trailhead, and also a little further west there is a pullout on the right.

Old Bunker Road/Coastal Trail

Trailhead near Marine Mammal Center, Marin Headlands
Directions: From Hwy 101 North, take the 2nd Sausalito exit before the Golden Gate Bridge. Make a right at the off ramp and go under the overpass. From Hwy 101 South take the first exit off the GGBridge onto Alexander Ave. From both directions take the first left at the Marin Headlands sign. Continue through the 5 minute tunnel on Bunker Road. Follow Old Bunker Road towards the Marine Mammal Center (veer right at the fork). We will meet at the end of this road where the trail starts.
This hike is transit friendly on the weekends! You can take public transportation on Saturdays via Golden Gate Transit Route 76.

Tennessee Valley

Tennessee Valley Trail, Old Springs Trail, Miwok Trail, Old Marincello Rd, and Fox Trail

Meet at the Tennessee Valley Road Parking Lot
Directions: From Highway 101 in Marin County, take the Highway 1/Shoreline Highway exit. After about 0.5 mile, turn left onto Tennessee Valley Road. Go about 1.5 miles to the parking lot

at the end of the road.

Wolfback Ridge and Rodeo Valley
Morning Sun Trailhead.
Directions: From San Francisco: Go north on highway 101, exit on to Monte Mar Dr toward Spencer Ave, Follow Monte Mar Dr to 1st left -Turn left to go under highway
http://maps.google.com/maps?q= 37.852933,-122.493417

Dipsea Trail
Dipsea Trailhead at the intersection of Highway 1 and Panoramic Highway near Stinson Beach.
Directions: From Highway 101 in Marin County, take the Highway 1/Shoreline Highway exit. Continue on Highway 1 towards Stinson Beach. Turn Right on Panoramic Highway just before coming into the town of Stinson. Immediately turn left into the dirt parking area.

Owl Trail
Muir Beach Overlook Parking lot.
Directions: From Highway 101 in Marin County, take the Highway 1/Shoreline Highway exit. Continue along Highway 1 for about 6.5 miles to the Muir Beach Overlook Turnoff on the left (the overlook will be a little over a mile past the Muir Beach turnoff). Follow this road to the parking lot.

Coast Marin Trail
Trailhead parking area on the Northwest end of the Golden Gate Bridge
Directions: From San Francisco: Take Hwy 101 North across the Golden Gate Bridge, Take the Alexander Avenue exit and curve left. Turn left at the stop sign and drive under the freeway overpass. From Hwy 101 Southbound, take the 2nd Sausalito exit before the Golden Gate Bridge and turn left at the stop sign. From both directions: Do not get back onto 101, but veer to the right up the steep hill. This is Conzelman Road. Shortly after turning onto Conzelman Road, take your 1st left into the parking area.

San Mateo
Sweeney Ridge, San Bruno
Sneath Road entrance to GGNRA
Directions: From San Francisco: Go south on 280, take the Sneath Ln exit, Take a right on Sneath Lane, continue until the end of the road.
http://maps.google.com/maps?q=37.619429,-122.4544161
Skyline College Parking Lot #2
Directions: From San Francisco: Go south on 280 to CA-1 (look for signs for CA-1/Pacifica). Exit onto CA-35 S/Skyline Blvd. Turn right at College Drive and then Left on College Loop Drive. Public transportation is available: SamTrans Routes 121, 123 and 140 provide weekday service to Skyline College. http://maps.google.com/maps?q=37.628366,-122.465048

Mori Point Ridge Trail

Trailhead parking lot at Shelldance Nursery
Directions: From San Francisco take Hwy. 280 South, Exit Hwy. 1 South/Pacifica Continue on Hwy 1 to the First Stoplight (Reina Del Mar) U-turn at this light, continue North on Hwy 1, past the Gas Station, past the Pacifica Police Station (all on the right) Shelldance entrance is on your right. (3 minutes from the light) A sign " Orchids" is at the entrance. Drive up the winding road to main parking area, over looking the beautiful Pacific Ocean

Mori Point
Mori Point Trailhead
Directions: From San Francisco: take Hwy 280 South, Exit Hwy. 1 South/Pacifica. Exit Sharp Park Road. Turn left (south) and keep going until road becomes Bradford Way. Near the end of Bradford Way, the Moose Lodge (big red building) is on the left. The trailhead is on the right at the fenced gate. Park on the street.

San Francisco
Fort Funston
Fort Funston Parking lot off of Skyline Blvd
Directions: From southbound CA 35 in San Francisco, pass John Muir Drive, then take the first right (signed Fort Funston). Bear right and continue to the parking lot.
From northbound CA 35 in San Francisco (just north of the San Mateo County border), make a U-turn at John Muir Drive. Drive southbound and take the first right (signed Fort Funston). Bear right and continue to the parking lot.

Coast Trail from Lands End
Parking Lot on El Camino Del Mar St.
Directions from Golden Gate Bridge: take Hwy 1 exit towards 19th Ave. Turn Right on Geary. Continue on Point Lobos Ave. Turn Right onto El Camino Del Mar. The parking lot will be on the left.

Muir Woods
Redwood Creek Loop, Bootjack Trail, Deer Park Fire Rd, Ocean View Trail, and Dipsea Trail
Muir Woods Visitor Center
Directions: Muir Woods is located 12 miles north of the Golden Gate Bridge. Take Highway 101 to the Highway 1/Stinson Beach Exit. Stay on Highway 1 and after about 3.5 miles; take a right onto Panoramic Hwy. Turn left onto Muir Woods Rd.

PORE Trailhead directions

Inverness Ridge

Meet at trailhead at end of Mount Vision Road.
Directions from Point Reyes Station: Take Hwy 1 through downtown. Turn Right to stay on Hwy 1. Turn Right on Sir Francis Drake (after you cross the bridge). Continue about 7 miles on Sir Francis Drake; you will pass through the town of Inverness and past Pierce Point Road on the right. After you pass Pierce Point Road, look for Mount Vision Road on the left. Turn left and travel up the hill until the road comes to a dead end (about 4 miles).

Cross Marin Trail

Meet at the trailhead on Platform Bridge Road
Directions from the North (Petaluma): Take Point Reyes-Petaluma Rd South toward Point Reyes Station. At the purple bridge (three-way stop) you will go straight. This puts you on Platform Bridge Rd. Just before Platform Bridge Rd intersects Sir Francis Drake there is a gravel pull-out where you can park. If you get to Sir Francis Drake you will have to find a safe spot to turn around and go back.
Directions from the South: From Hwy 101 take the Sir Francis Drake exit. Follow Sir Francis Drake for several miles until you are out of the main towns and past Samuel P Taylor State Park. Then, keep your eyes out for Platform Bridge Rd on the right. Make a right there and you will see a gravel pull out on the left where you can park.

Bolinas Ridge Trail

Meet at the trailhead on Sir Francis Drake.
Directions from the North (Petaluma): Take Point Reyes-Petaluma Rd South toward Point Reyes Station. At the purple bridge (three-way stop) you will go straight. This puts you on Platform Bridge Rd. After several miles Platform Bridge Rd intersects with Sir Francis Drake. Turn Right at that intersection and travel about a mile. Keep an eye out for the pull out on the left side of the road.
Directions from the South: From Hwy 101 take the Sir Francis Drake exit. Follow Sir Francis Drake for several miles until you are out of the main towns and past Samuel P Taylor State Park. Then, keep your eyes out for Platform Bridge Rd on the right. Continue on Sir Francis Drake but watch for the pull-out on the left side of the road shortly after the intersection with Platform Bridge Rd.

Coast Trail

Meet at the trailhead near the Education Center.
Directions from Point Reyes Station: Take Hwy 1 through downtown. Turn Right to stay on Hwy 1. Turn Right on Sir Francis Drake (after you cross the bridge). Next take a left on Limantour Rd. Follow Limantour Rd for several miles until you see a sign the directs you to the Education Center. Take that left and follow the road to the Coast trailhead (at the first parking area on the right).

Abbotts Lagoon

Meet at trailhead on Pierce Point Road.
Directions from Point Reyes Station: Take Hwy 1 through downtown Point Reyes Station. Turn Right to stay on Hwy 1. Turn Right on Sir Francis Drake (after you cross the bridge). Continue about 6 miles on Sir Francis Drake; you will pass through the town of Inverness. You will need to turn right onto Pierce Point Rd, and then stay left at the intersection with L Ranch Road. There will be a small parking area at the trailhead for Abbotts Lagoon on the left side of Pierce Point Road.

Tomales Point

Meet at the trailhead at the end of Pierce Point Road.
Directions from Point Reyes Station: Take Hwy 1 through downtown Point Reyes Station. Turn Right to stay on Hwy 1. Turn Right on Sir Francis Drake (after you cross the bridge). Continue about 6 miles on Sir Francis Drake; you will pass through the town of Inverness. You will need to turn right onto Pierce Point Road, and then stay left at the intersection with L Ranch Road. Continue on Pierce Point Road until it comes to a dead end. There is parking here and the trailhead is nearby.

Ocean Lake Loop

Let dispatch know that you are going to be driving out to Wildcat Camp before you leave
From Bear Valley Rd, take Highway 1 South to the Five Brooks Trailhead. Go through the gate (you will need a gate key) and drive Stewart Trail to Wildcat Camp. Stewart Trail is well maintained, and any car should have no problem getting back there. You can park at Wildcat Camp.
The Ridge Trail can be accessed along Stewart Trail too.

Palo Marin

From Bear Valley Rd, take Highway 1 South. Drive several miles until you see Olema-Bolinas Rd, turn right. Take Olema-Bolinas Rd until you reach the stop sign at Mesa Rd, turn right. Mesa Rd dead ends at the Palo Marin trailhead. You will pass the Point Reyes Bird Observatory on Mesa Rd.

Horse Trail

Head north on Bear Valley Rd. Turn left onto Limantour rd. Horse trail starts at the Bear Valley Rd and Limantour Rd intersection, so you can pull out wherever and start your survey.

Estero Trail

Take Bear Valley Rd north. Turn left at intersection with Sir Francis Drake Hwy. You will pass Pierce Point Rd on the left and later Mt Vision Rd on the left. After you pass Mt Vision rd keep your eye out on the left for the sign pointing left that says “Estero Trail” turn left there. After another mile or more you will reach the parking area at the trailhead.

Limantour Spit
Take Bear Valley Rd north, and turn left on Limantour Rd. Follow this road for several miles until you get to Limantour Beach, you can't miss it!!

Sky Trail
Take Bear Valley Rd north and turn left onto Limantour Rd. There is a small parking area on the left side of the road. If you get to the Bayview trailhead, you missed it!

Bayview Trailhead
Take Bear Valley Rd north and turn left onto Limantour Rd. There is a trailhead on the right side of the road. If you get to the sign for the youth hostel you missed it!

Muddy Hollow
Take Bear Valley Rd north and turn left onto Limantour Rd. Keep your eye out for the sign for the youth hostel on the left, you will want to turn RIGHT here. Follow the gravel road to the parking area. You can access several trails from here.

NPS D-963/100210, August, 2009

National Park Service
U.S. Department of the Interior

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